Metallurgist

МЕТАЛЛУРГ

NUMBER 11 1961

METALLURGIST

METALLURGIST is published in translation by the Board of Governors of Acta Metallurgica, with the financial support of the NATIONAL SCIENCE FOUNDATION.

An arrangement with Mezhdunarodnaya Kniga, the Soviet Book Export Agency, makes available both advance copies of the Russian journal and original glossy photographs and artwork. This serves to decrease the necessary time lag between publication of the original and publication of the translation and helps to improve the quality of the latter.

The translation and production of METALLURGIST are being handled by Consultants Bureau Enterprises, Inc.

Translation Editor:

PROFESSOR BRUCE CHALMERS, *Harvard University*

Acta Metallurgica is an International Journal for the Science of Metals. It is sponsored by the AMERICAN SOCIETY FOR METALS and the AMERICAN INSTITUTE OF MINING, METALLURGICAL, AND PETROLEUM ENGINEERS and is published with the cooperation of the following societies:

Japan Institute of Metals
Physical Society of Japan
Instituto del Hierro y del Acero (Spain)
American Institute of Physics
American Society for Testing Materials
Svenska Metallografförbundet
Svenska Nationalkommittén för Kemi
The Physical Society of Finland
The Indian Institute of Metals
West of Scotland Iron and Steel Institute
Associacao Brasileira de Metais
Institute of Metals (Great Britain)
Iron and Steel Institute (Great Britain)
Société Française de Metallurgie
Deutsche Gesellschaft für Metallkunde
Verein Deutscher Eisenhüttenleute
Selskabet för Metalforskning (Denmark)
The Australian Institute of Metals
Netherlands Physical Society
Koninklijke Nederlandse Chemische Vereniging (Netherlands)
Associazione Italiana di Metallurgia

The Board of Governors of Acta Metallurgica is constituted as follows:

Professor Ulrich Dehlinger

Dr. C. H. Lorig
Professor D. S. Clark
Professor Robert Maddin
Mr. G. M. Young
Professor G. W. Rathenau
Dr. W. Boas

Professor Robert L. Sproull

Dr. J. H. Hollomon, *Secretary-Treasurer*

Issued monthly. One volume per annum consisting of 12 issues and containing approximately 50 pages per issue.

Annual subscriptions (which must be paid in advance) are:

To libraries, institutions, and individuals, $25.00 (£ 9) including postage.
To members of cooperating and sponsoring societies of Acta Metallurgica, $12.50 (£ 4/10) including postage.
Single issues, $4.00 (£ 1/8).

Orders should be sent to: BUSINESS MANAGER

ACTA METALLURGICA

122 EAST 55TH ST. · NEW YORK 22, N. Y.

METALLURGIST

A translation of METALLURG, the monthly industrial technical journal of the Ministry of Iron and Steel of the USSR

Translation Published April, 1962

No. 11, pp. 501-548 November, 1961

CONTENTS

	PAGE	RUSS. PAGE
More Metal for the Nation	501	1
THE BLAST-FURNACE INDUSTRY		
Errors in Regulating Gas Flow and Distribution of Materials in the Blast-Furnace. I. G. Polovchenko	503	3
M. M. Gladkii	507	7
An Efficient Design of Molds for Casting Machines. S. V. Vasil'ev	509	8
THE STEELMAKING INDUSTRY		
Improvement in the Dephosphorization of Metal during the Melting Period. V. F. Bogatenkov, O. Ya. Vainshtein, B. F. Zverev, and S. G. Firsov	512	11
Increase in the Durability of the Arches of the Open-Hearth Furnace. M. G. Bryunetkin and A. A. Dobrokhotov	514	13
The Replacement of Cast Steel Stoppers by Ceramic Refractories Containing Graphite in the Top-Pouring Steel. A. S. Zhikharevich, A. G. Karaulov, B. I. Panich, I. I. Sheiko, V. F. Polyakov, and S. F. Khalemskii	518	18
ROLLED AND TUBULAR PRODUCTS		
The Rolling of 7-9 Ton Ingots by the Semi-Twin Method on a 1150 mm Slabbing Mill. I. Ya. Tarnovskii, Yu. I. Odinokov, G. G. Kustobaev, and B. D. Sychkov	521	20
Roller Guide Equipment for Rolling Mills. V. A. Drozd, P. I. Tetel'baum, and I. F. Prikhodko	523	22
The Chief Directions of Growth of the Soviet Tube Industry. Yu. M. Matveev and V. P. Markov	526	25
Development of the Production of High-Strength Cast-Iron Pipes. V. G. Shiyan and V. A. Davydov	528	27
All-Union Conference of Rolling-Mill Operators—Production of Grade-Steel Rolled Goods	530	29
EXPERIENCE OF INNOVATORS		
The General Design Office of the Chelyabinsk Metallurgical Plant. P. F. Smirnov	534	32
En Route to Increasing the Productivity. G. I. Brodskii	536	33
FOR LABOR SAFETY		
Let Us Constantly Study and Introduce the Positive Industrial Experience in Improving Hygiene of Working Conditions. M. E. Zhilo	539	35
FROM THE HISTORY OF TECHNOLOGY		
M. V. Lomonosov and Ferrous Metallurgy, in Commemoration of His 250th Anniversary. V. B. Yakovlev	544	38
OBITUARY		
Aleksei Mikhailovich Piterskii	546	40

MORE METAL FOR THE NATION

Translated from Metallurg, No. 11,
pp. 1-2, November, 1961

The metallurgists of the Soviet Union have successfully fulfilled the State Plan for the first two years of the Seven Year Plan. On the basis of Socialist competition, workers in ferrous metallurgy in the first two years have overfulfilled the plan for iron, steel, rolled stock and other production.

In the third year of the Seven Year Plan the metallurgists were inspired by the resolution of the January Plenum of the Central Committee of the Communist Party of the Soviet Union to hold the 22nd Congress of the Communist Party of the Soviet Union, which called for an increase in the labor and political activity of workers at all ferrous metallurgy plants, directed to the early fulfillment of the plan for the third year of the Seven-Year Plan to meet the demands of the 22nd Congress. In a competitive spirit the huge army of Soviet metallurgists commenced the struggle for the maximum utilization of production reserves, to reduce production holdups, to achieve the greatest use of production capacities and eliminate inefficiency.

Most of the metallurgical plants are working well and successfully to fulfill their promises. In nine months of 1961 the metallurgists gave the country 37.7 million tons of iron, 52.5 million tons of steel, 40.7 million tons of rolled stock, amounting to 109, 109 and 108% respectively of the 9 months for the previous year.

The collectives of the plants "Zaporozhstal' ", "Dneprospetsstal' ", the Serov Combine, Stalino, Zakavkaz Metallurgical Plants and many others are working particularly well.

The collective of metallurgists at the "Zaporozhstal' "Plant has considerably overfulfilled its quota in honor of the 22nd Congress of the Party-it has produced in excess of the plan many thousands of tons of iron, steel and rolled stock. The steel smelters of the fifth open-hearth furnace, Comrades Stan, Kiiko and others,have achieved the world's best indices, increasing the yield of steel from 1 m^2 of hearth area to 13.2 tons. On October 19 of this year the collective reported to the Party Congress on the successes achieved.

Outstanding successes have been achieved by the collective of the "Dneprospetsstal' " Plant. Together with a constant increase in production of steels and rolled stock with existing capacities the collective of this plant is increasing from month to month the amount of smelted grades of steel, it is constantly introducing new and leading techniques into production technology. In anticipation of the Congress, a collective of "Dneprospetsstal' " workers has overfilled its quota for steel and rolled stock by several thousand tons. The collective of the Petrovskii Plant has fulfilled the nine-month plan for the whole metallurgical cycle.

The collectives of many metallurgical plants have increased not only the amount of metal produced but have also considerably improved the technical and economic indices of operation. For example, the blast furnace workers in the Russian Federation during eight months of this year achieved a coefficient of utilization of useful volume for the blast furnaces with respect to nominal operating time of 0.691 with a planned figure of 0.695, and the blast furnace workers of the Cherepovetsk Metallurgical Plant have achieved 0.537 with a planned figure of 0.577.

The collective of one of the blast furnaces of the Krivoi Rog Metallurgical Plant in nine months has produced more than twice its quota of iron, saved 26,827 tons of coke; the coefficient of utilization of useful volume at this furnace was 0.787 with a planned figure of 0.811. Efficient use is being made of the volume of blast furnaces by the workers at the Serov Metallurgical Combine, the Chelyabinsk Metallurgical Plant and many other plants.

Many open-hearth workers have also produced good technical and economic indices. For example, the steel smelters of the Alchev Metallurgical Plant have achieved a yield of steel from 1 m^2 of hearth of 9.17 tons with a planned figure of 9.08 tons, and in nine months the collective of the open-hearth furnace of the Krivoi Rog Metallurgical Plant has overfulfilled its promises for the smelting of steel by several thousands of tons, it has achieved a yield from 1 m^2 of hearth area of 8.07 tons with a planned figure of 7.76 tons.

In the course of Socialist competition for the early fulfillment of the plan for the third year of the Seven Year

Plan and in honor of the 22nd Congress of the Communist Party of the Soviet Union, at the ferrous metallurgy plants a large number of leading workers and production innovators have appeared, showing examples of high productivity work – foremen of the blast furnace department of the "Zaporozhstal' " Plant, Comrades Tarasov, Tsimbal, Vovk, steel smelters of the Kuznetsk Metallurgical Combine, Hero of Socialist Labor Burkatskii, Kuznetsov, Shabalov and many others.

Many leading workers and production innovators – communists, having achieved high indices in anticipation of the Congress – have been honored by being chosen as delegates to the 22nd Congress of the Communist Party of the Soviet Union. These include the foreman of the blast furnace department of the Cherepovetsk Metallurgical Plant, which has achieved a coefficient of utilization of useful volume of 0.505 for the blast furnace, Comrade Novikov, steel smelters of the Serov Metallurgical Combine, Comrade Izyurov and from the Zlatoustovsk Metallurgical Plant Comrade Manyukin, the roller of the Pervoural'sk New Pipe Plant, Comrade Pogodin and others.

A group of steel smelters of the "Élektrostal' " Plant headed by Comrade Zhuravlev, considering the production possibilities, asked the administration to increase their norm by 4%. Their request was granted and now the steel smelters are fulfilling these increased norms.

In the vanguard of national competition there are production innovators and leading workers striving for title of collectives and shop workers of communist labor. Not only individual brigades and departments but whole collectives of the largest metallurgical plants and combines are competing for the right to be called a plant of communist labor. Among those competing for this title are collectives of the "Zaporozhstal' ", "Dneprospetsstal' ", "Elektrostal' "Plants, the Serov Combine, Zakavkaz Metallurgical Plant, Pervoural'sk New Pipe and many other plants. The metallurgists of the Serov Metallurgical Combine and the Stalino Metallurgical Plant, having fulfilled their quotas in a shorter period of time in honor of the 22nd Congress of the Communist Party of the Soviet Union, have shown a truly national approach to work and have asked the Councils of National Economy to increase their plan for steel smelting. Their request was granted and now these plants are successfully fulfilling the increased plan.

In the new program of the Communist Party of the Soviet Union tremendous possibilities are outlined for further increase in Soviet industry. In the next 20 years there will be a tremendous development in ferrous metallurgy.

In the speeches of the delegates to the 22nd Congress of the Communist Party of the Soviet Union it was emphasized that the country's metallurgists have tremendous tasks in fulfilling the Seven-Year Plan. They must improve the structure of metallurgical production, increase the fraction of low-alloy steel, the production of heat-resistant and other grades of metal and expand the production of various rolled profiles.

The delegates of the Russian Federation promised the Congress that the Seven-Year Plan would be fulfilled before the planned date and the country would obtain in excess of the plan about 13 million tons of steel and 10 million tons of rolled stock.

The metallurgists of the Ukraine in 1961 will have increased the production of iron by 60%, steel by 66%, and rolled stock by 69% compared with 1955.

Exceptionally important in the fulfillment of the Seven-Year Plan is the use of the tremendous reserves which exist at each plant. For example, if the coefficient of utilization of volume of the Ukrainian Blast Furnaces reaches the indices of the "Zaporozhstal' " and Dzerzhinskii Plants, the production of iron will increase by 2 million tons per year.

In his speech the First Secretary of the Central Committee of the Communist Party of Kazakstan D. A. Kunaev stated that for the organization of new powerful metallurgical production in the east the building of the Kacharsk and Lisakovsk Mining-Enrichment Combines must be stepped up and the capacity of the Sokolovsko-Sarbaisk Combine must be increased from 25 to 55-60 million tons of ore per year. This will make it possible to supply the whole metallurgy of the Southern Urals with ore and also to build alongside the Karagandinsk Plant a plant with the same capacity.

Soviet metallurgists know that the main economic task of the party and the whole nation is to create a material and technical base for Communism within the next 20 years. They will eliminate the faults existing in the work of ferrous metallurgy plants and will apply all their energies to produce as much metal as the nation requires.

ERRORS IN REGULATING GAS FLOW AND DISTRIBUTION OF MATERIALS IN THE BLAST-FURNACE

I. G. Polovchenko, Cand. Technical Science,
Head of Smelting Laboratory, Dzerzhinsk Plant

Translated from Metallurg, No. 11,
pp. 3-6, November, 1961

In Metallurg, No. 8, 1960, appeared the article by A. N. Chechuro and I. L. Kolesnik: "Errors in Regulating Gas Flow and Distribution of Materials in the Blast-Furnace." One of the responses to this article appears below.

Movement of Materials and Gases in the Peripheral Zone of the Furnace

Uneven distribution of blast among the tuyeres has a strong influence on the functioning of the periphery of the blast-furnace. The difference in the quantity of the blast entering various tuyeres reaches 25%, even with relatively smooth descent of the burden. Consequently, the intensity of coke combustion and liberation of hearth volume opposite various tuyeres may differ by 25% and in particular instances by more. However, this does not mean that the relatively large quantity of gas which forms at the tuyeres passes through the entire column of charged materials, even in the tuyere zone; this stream flows into adjacent zones and even passes more or less evenly along the periphery. Measurements of the static gas pressure along the periphery at various horizons of the stack do not reveal a significant vertical difference in gas pressure.

Even in cases of appreciable disruption of furnace operation (the formation of accretions, channel flow, and so on) the pressure at various points of the working space at the same stack horizon does not vary significantly, especially within a limited sector of furnace cross section (limited to 2-3 tuyeres). Under normal operating conditions, the pressure is practically the same at all points in the cross section.

If one or two adjacent tuyeres are closed off, the flow of gas in the burden above them does not cease; it diminishes slightly. Gases forming at neighboring tuyeres spread to the zone of the working space of the closed tuyeres and react with the materials found there.

However, due to the cessation of coke combustion at the closed tuyeres, movement of materials in this zone may be significantly curtailed; the rate of movement decreases, and the level of the charge above these tuyeres will be noticeably different than at other zones.

The temperature of the peripheral gas above the closed tuyeres will, as a rule, be higher than at other sections of the periphery. This is confirmed by extended observations of the radiometric level gage which we proposed and also by the results of more recent investigations. The greater the rate of movement of materials, the lower the temperature of the gas; the lower the rate, the higher the temperature.

A nonuniform relation between the ore and the coke over a furnace cross section has, in its turn, a strong influence on the rate of movement of the burden and the temperature of the peripheral gas. If the vertical movement of the burden is determined by coke combustion and smelting of raw iron ore, then it depends on variation in the quantity of blast and the ore: coke ratio in a given sector of the furnace.

In modern, efficiently operating furnaces, the ore load reaches 3.3 tons per 1 ton of coke. With a dry weight of coke of 0.5 ton/m^3 and fluxed agglomerate of 1.8 ton/m^3, the agglomerate occupies 47-48% of the total volume, and the coke 52-53%. On the periphery, where the ore load is smaller, the volume occupied by coke reaches 60% or more.

According to our estimates, a variation in the blast entering a tuyere or a group of adjacent tuyeres of 25% will be accompanied by a change in the rate of descent of materials in a given sector of the furnace of 16%. A variation in the distribution of ore and coke of 25% will, in its turn, occasion a fluctuation in the rate of descent of the burden of 10%.

If the mean rate of descent of materials at the mouth of the furnace is equal to 150 mm/min, or 9 m/hr, then a change in this rate of 15% will occasion an advance or lag in the level of materials in a specified sector of the mouth of 1350 mm after an hour.

In any sector of the furnace whatever, a concentration of coke (without ore) on the periphery will lead to a decrease in the rate of descent of materials, the quantity of blast remaining constant at 40%, i.e. the rate will be 5.4 instead of 9 m/hr, and the level of the burden will lag by 3.6 m/hr.

A concentration of the ore charge in any sector of the furnace whatever will be accompanied by an increase in the rate of descent of materials until such time as the combustion of coke and heat of the blast can smelt the ore component of the burden. If the heat is insufficient, the movement of materials should cease entirely.

It is clear that if the peripheral distribution of ore and coke is even, then a nonuniform rate of descent of materials can be caused only by an uneven distribution of blast among the tuyeres. This can be explained by a clogging of the tuyeres with slag or by a change in the viscosity of the slag within the zone of any tuyere focus. Consequently, unevenness is not directly connected with the distribution of materials and gases at a given moment of furnace operation, although in the end it is determined by the distribution of materials.

Dependence of Smelting Parameters on the Evenness of Distribution of Blast and Ore Load over the Furnace Cross Section

Indices	With even distribution of materials, blast, and gas	With even distribution of blast and gas		With uneven blast	
	ore load, tons/ton coke				
	3	3.3	2.7	3.3	2.7
Volume occupied by ore, %	45.5	47.7	42.8	47.7	42.8
Volume occupied by coke, %	54.6	52.3	57.2	52.3	57.2
Quantity of gas per 1 ton of ore charge, m^3	1730	1570	1920	1500	2000
Average time charge remains in the furnace, hr	6.5	6.23	6.8	–	–
Rate of movement of material averaged over the furnace from the top to the tuyeres, m/hr	3.24	3.38	3.09	–	–

The Movement of Materials and Gases in Intermediate Furnace Zones

Uneven distribution of blast among the tuyeres has a substantial effect on the descent of the burden not only at the periphery, but also in intermediate zones – above the oxidizing zones and somewhat near to the axis of the furnace. However, in this zone, the greatest volume (more than 50%) is occupied by the ore charge. Therefore, fluctuations in the distribution of ore here elicit a more sensitive reaction than fluctuations in the blast.

If, for example, ore (agglomerate) occupies 55% of the volume and coke 45%, then variations in the blast and distribution of ore of 25%, according to our estimates, will be accompanied by changes in the rate of descent of materials by 13.75 and 11.25% respectively.

The intermediate zone determines the quantity of gaseous materials passing through the furnace and the intensity of the smelting process. Here, the maximum rate of movement of materials is most steadily maintained; the main quantity of gases moves through the intermediate zone, as witnessed by a comparison of the CO_2 content in the top

gases and its radial distribution over a furnace cross section. In peripheral and axial zones, the CO_2 content is usually lower than 8%, in the intermediate zone more than 15%, and in the top gases 13-15%.

Judging by the ore: coke ratio, the gas permeability of the intermediate zone should be a minimum; however, it increases to some extent with increased rate of descent of materials due to loosening of the burden.

In speaking about the temperature of the gas before its exit at the charge level, it is not sufficient to remark that its temperature is higher where the gas flow is greater, and, on the other hand, lower where the rate of gas flow is less. The temperature of the gas is basically a function of the quantity of materials, mainly ore and flux with which the gas has reacted, and this quantity not only depends on the distribution of ore and coke, but also on the intensity of gas flow (the quantity of gases passing a given cross section per unit time).

Therefore, it is correct to speak of the quantity of gas passing a given cross section per unit of smelted ore.

With an even distribution of ore and coke, identical rates of their descent, and the same intensity of gas flow over a whole furnace cross section, the temperature of the gas should be even over the charging level at its exit.

If it is assumed that the area of the intermediate zone comprises a half to the furnace cross section, then increasing the ore load with respect to coke in this zone should be directly followed by a corresponding decrease in the peripheral and axial zones. With an average load of 3 tons of ore per 1 ton of coke, increase of the ore load in the intermediate zone, for example, 3.3 tons for 1 ton of coke causes a decrease in the peripheral and axial zones to 2.7 tons/ton. It is evident from the table how other indices of the process change hereby. It is also shown what happens to the quantity of gas per unit of ore charge if the blast at the tuyeres is changed by 10% by the redistribution of gas. As is evident, fluctuations in the quantity of gas per ton of ore charge may reach 25%. It is fully understandable that this unavoidably occasions a change in the thermal conditions by zones along the entire furnace. This is explained by the fact that in the intermediate zone the temperatures from the charge level to the oxidizing zones in the hearth are a minimum.

The low temperature of the gases and the relatively high rate of descent of the burden point to a concentration of the ore component of the charge. At the same time, a low temperature of the gases and a high rate of descent of the burden themselves occasion this concentration as a result of the re-distribution of materials toward the zones of higher rate of descent.

Movement of Materials and Gases in the Axial Zone of the Furnace

In the axial zone, the volume of ore materials is less than 47%, and fluctuations in blast distribution have here almost no influence on the movement of materials, but the vertical rate of movement is frequently a maximum. This is not determined by the coke consumption in the axial zone itself, but rather by the transfer of coke to the intermediate and peripheral zones below the foci of oxidation where it then burns.

Here, as between adjacent tuyeres, there may occur a shifting of gas from zones of high rate of burden movement to zones with a lower rate in which this shifting will increase the temperature of the gas in the upper part of the stack.

For example, if the rate of movement of materials in the axial zone increases more coke will be transferred to the oxidizing zones, but the gas produced from this coke will go primarily to the periphery and not to the axial zone. This will lead to an increase in temperature of the gas on the periphery and a decrease on the furnace axis.

With an even distribution of blast among the tuyeres, the processes in the axial zone have no influence on those at the periphery. The axial zone is located along the furnace axis and determines only the radial distribution of materials. In case of an uneven distribution of blast among the tuyeres, the axial zone shifts away from the axis of the furnace; disruption of the furnace is redoubled due to the unilateral transfer of coke toward the peripheral and intermediate zones.

If furnace operation on the periphery is uneven, it is impossible to achieve an optimal radial distribution of materials and gases. For this reason, new specifications for regulating peripheral operation by changing the program of the charge distributor have been introduced at the Dzerzhinsk Plant In choosing a charging system, it is, in our opinion, necessary that one strive to achieve an even relative distribution of the ore and coke mounds around the mouth; to regulate the distribution of gas flow peripherally, one must only alter the level of the materials without changing the relative distribution of the ore and coke mounds.

According to the new specifications, it is necessary to lower the charge level by shunting particular stages of

the distributor in those sectors where the temperature of the peripheral gas is a maximum and raise the charge level in sectors where the temperature of the peripheral gas is a minimum. A local increase in the charge level increases the resistance to the passage of gases by increasing the height of the column of materials and also by concentrating the finer fractions. As a result, the amount of blast entering the tuyeres in sectors with lower peripheral gas temperature is reduced, coke combustion diminishes, and the rate of descent of materials decreases; after this, the temperature of the gas here must increase.

On the other hand, a decrease in the charge level reduces the resistance to the passage of gases as a result of lowering of the height of the burden and the rolling off of the coarser fractions. The quantity of blast entering the tuyeres in a sector with maximum peripheral gas temperature increases, the rate of coke combustion and descent of the burden increases, and part of the gas rises through contiguous zones which leads to a decrease in the temperature of the peripheral gas.

This system of regulating the smelting by the temperature of the peripheral gases has not yet been adopted by all the foremen of the plant, but it has already played a major role in improving the operation of the furnaces.

The difficulty is not in the regulation itself, but in choosing a charging system which will provide a more or less even circumferential distribution of ore and coke. The choice of a charging system involves many other considerations: the radial distribution of materials, the capacity of the charging mechanism, the design of the receiving hopper, and the position of the skips on the unloading line relative to the receiving hopper, i.e. the position of the mounds in the small-bell hopper.

Nevertheless, a change in the program of the distributor, as a rule, immediately improves the parameters of distribution of gas flow and furnace operation.

Our experience shows that automatic regulation of furnace operation according to the temperature of the periphery pertains directly only to regulation of the level of materials without altering the ore: coke ratio.

The article by A. N. Chechuro and I. L. Kolesnik does not altogether correctly reflect the results of changing the operating program of the charge distributor, and it contains a peculiar treatment of some circumstances; the authors try to extend the processes taking place in the peripheral zone to apply to the entire furnace cross section. Proceeding from logical analysis of the interrelation between the movement of the burden and gases, the authors consider a concentration of ore in zones having a minimum peripheral gas temperature applicable; one cannot agree with this.

Appreciable concentration of ore in a sector of colder operation may lead to a complete cessation of the movement of the burden, after which a gradual heating of the region will begin. Such a method cannot be recommended for regulating the smelting process, because its application would at first redouble disruption of furnace and then slowly correct it. Utilization of such a method involves appreciable losses of time and furnace capacity.

The response of V. I. Loginov and N. N. Chernov also contains many inaccuracies which do not serve to clarify the questions touched on by A. N. Chechuro and I. L. Kolesnik. For example, the explanations of the formation of channels in the burden with more intense gas flow, which have long been recognized in practice, are interesting. As previously noted in the development of the theory of the blast furnace, special attention was devoted to the movement of gases; the movement of the burden was essentially unevaluated. Therefore, the concept of "channels" refers to movement of gas in the burden, and the formulation repeated by N. N. Chernov relative to the nature of this phenomenon may be considered successful. However, the influence of channel formation on the parameters and course of the smelting process is not correctly interpreted.

In case of a "channel", the temperature of the peripheral gas will increase only when the channel is situated right at the point where the thermocouple is inserted. If the positions of the thermocouple and the channel zone do not coincide (and this often happens), then passage of part of the gas from the hearth through the channel without utilizing the physical-chemical energy of the gas will lead directly to a cooling of a sector of the furnace from the oxidizing zones to the charge level, and the temperature of the gas may be increased only above the materials as a result of its neutralization.

These are instances of persistent movement of gas through channels with accompanying blowing out of materials through the charging apparatus; as a result of fines being blown out of the burden toward openings in the hopper or housing, the corresponding sector of the furnace becomes overloaded with coarser materials. The ore load in this sector decreases, since coke contains practically no fines (dust). In spite of this and the well developed stream of gas,

the temperature of the periphery in this sector is, as a rule, lower than in others. This is explained by the increased amount of blast entering the tuyeres in this sector, the accelerated descent of the burden, the deficient utilization of gas in the vicinity of the thermocouple, and the partial transfer of gas to contiguous regions. Therefore, the sector of the furnace undergoing extensive blowing out of materials through the charging apparatus, as a rule, operates colder along the entire height of the furnace—from the tuyeres to the charge level.

M. M. Gladkii

Dzerzhinsk Plant
Translated from Metallurg, No. 11,
pp. 7-8, November, 1961

Forced smelting with an appreciable quantity of fines in the agglomerate is characteristic for the blast-furnaces at the Dzerzhinsk Plant. Seventy to eighty percent of the agglomerate in the burden of the blast-furnaces comes from the plant's sintering mill and 10-20% is YuGOK agglomerate. The granular composition of the agglomerate charged into the furnaces contains the following fractions, %:

	Fraction, mm			
	0-3	3-10	10-25	25
Local agglomerate	7-14	36-48	20-32	20-29
YuGOK agglomerate	11-15	27-33	16-20	32-46

Air input per minute into the large furnaces amounts to 2.25-2.35 of their effective volumes. Curtailment of coke consumption has been achieved by the use of natural gas, which in turn lowered the gas permeability of the burden.

The four-skip system of charging (basically O-O-C-C) is used in the furnaces with a coke charge of 5.5-6.0 tons. Under such conditions of blast-furnace smelting, regulation of the distribution of materials at the mouth involves certain difficulties.

The nature of distribution of gas streams across the furnace is ascertained by the temperature of the peripheral and total top gases, by analysis of the gases along a radius of the mouth, and by other indices. In regulating the gas stream at the Dzerzhinsk Plant, the system of charging was altered such that a larger amount of ore reached zones of increased temperature, and a smaller amount reached those of lower temperature.

However, as is pointed out in the article by A. N. Chechuro and I. L. Kolesnik, such regulation does not always produce the required results. At the same time, the temperature of the peripheral gases may drop when using the charging system C-C-O-O, and increase when using O-O-C-C. This phenomenon, which is in contradiction to existing concepts, is fruitfully exploited by the leading crews of the mill in everyday practice. For example, using the principal charging system, suppose the temperature of the peripheral and mouth gases becomes higher than normal. The foreman establishes the charging system C-O-O-C or C-C-O-O; the temperature of the peripheral gases drops, and unevenness in the distribution of gas streams in the blast-furnace decreases. This gave A. N. Chechuro and I. L. Kolesnik reason to draw the conclusion that "the existing concepts of gas flow and distribution of materials at the mouth are altogether contrary to what actually takes place."

In our opinion, this assertion is in need of supplementary argumentation on the basis of more extended verifications under various conditions of blast-furnace operation. When the charge loaded into the blast-furnace contains a larger quantity of finer fractions, a mound of low permeability forms at the mouth, resulting in the very uneven distribution of gas over the furnace cross section; a shifting of materials takes place which essentially consists in the following: during charging, the finer ore portions which fall to points of higher gas permeability are taken up by the rapidly moving gas stream and redistributed to places where gas movement is less intensive. As a consequence of this, the finer ore portions are deposited not at points with high gas permeability, but at those with low permeability; this

makes the distribution of materials and gas flow over the furnace cross section still more irregular. Precisely by this may easily be explained the decrease in temperature of peripheral gases using the charging system C-C-O-O.

Using the charging system C-C-O-O, the periphery of the furnace is loaded first, which to some extent reduces the opposing force of the gas stream in this zone. The charge enters the cone in the central part of the furnace last, principally in the form of ore materials, the finer fractions of which are taken up by the gas stream and deposited on the periphery. The distribution of gas flow becomes more even.

The basic charging system is restored after attaining normal values of the temperature in the gas conduits and of the CO_2 content in the total top and peripheral gases and after approach of the temperature of peripheral gases to normal.

It is also easy to explain the shifting of gas streams toward the periphery of the furnace under a charging system O-O-C-C and well developed central gas flow. This happens when a cone with walls steeper than the angle of repose of coke forms at the center of the mouth. In this case, under a charging system O-O-C-C the ore portion of the burden falling to the center of the furnace is always greater than under the system C-C-O-O.

If one agrees with the opinion of A. N. Chechuro and I. L. Kolesnik, then it is difficult to explain why gas streams have been successfully regulated (and at other plants continue to be regulated) assuming that a high temperature of the peripheral gases indicates increased gas permeability in the given zone. Moreover, it has been established in practice that a definite interrelation exists between the temperature of the gas and its CO_2 content: in samples of gas taken from points at a high temperature, the CO_2 content is lower than in those taken from points at a lower temperature.

If it is supposed that in channels the temperature of the gases is lowest and the CO_2 content highest, then in regions of channel flow one should observe stronger heating of the hearth. In addition —and this is pointed out by A. N. Chechuro and I. L. Kolesnik —within 3-4 hr after the beginning of channel development, unreacted materials appear at the tuyeres in this sector. The degree of reduction of the burden depends not so much on the length of time it remains in the furnace as on contact with reducing agents and the quantity of gases entering per unit of materials. The gas streams, being more mobile, always flow in largest quantities along paths of least resistance. Consequently, one cannot suppose that the ratio of the amounts of materials and gases flowing through the channel is larger than in other zones of the furnace cross section. The sharp cooling of the hearth in the channel zone can be explained only by insufficient utilization of gases forming in this sector and flowing through the channel.

The high temperature of peripheral gases using the charging system O-O-C-C bears witness only to the shifting of materials. Decrease in the temperature on the periphery after changing the charging system to C-O-O-C indicates a change in the conditions of materials' distribution and that a larger amount of the ore portion of the burden is being retained on the periphery. This is a result of a change in the direction of shifting of the ore fines or a weakening of the opposing force of the gas stream at the moment of charging.

If channel flow cannot successfully be stopped by charging the ore portion of the burden directly into the channel, then loading should be done such that it falls there by rolling down the sides of the cone or by destroying the walls of the channel.

As measures to prevent the undesirable shifting of gas streams toward the center or periphery of the furnace and the formation channels, a complex system of charging (2 charges O-O-C-C and 5 charges C-O-O-C or otherwise) and periodically loading the furnace with the ore and coke components separately in doubled charges can be recommended.

AN EFFICIENT DESIGN OF MOLDS FOR CASTING MACHINES

S. V. Vasil'ev

Novolipetsk Metallurgical Plant

Translated from Metallurg, No. 11,
pp. 8-10, November, 1961

The casting machines of the NLMP are presently equipped with triple ingot molds having high durability, small iron losses as scrap, and good release of ingots from the molds.

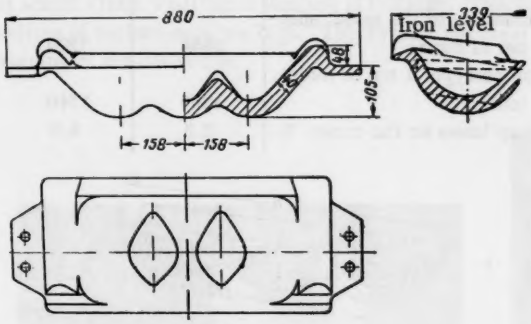


Fig. 1. Single ingot mold.

At first (in 1953), double ingot molds were used instead of the single ingot molds (Fig. 1). The layer of fluid iron in the mold had a trapezoidal cross section 80 mm in height (Fig. 2a). Impairment of the cross-sectional form of the ingots, which did not allow them to fall freely, and the low mass of the molds, which resulted in the ingot not hardening thoroughly and not parting from the mold, caused scaling. Excessive separation of graphite, leading to disruption of the surface of the ingot, was observed due to the slow freezing of the iron.

The trapezoidal ingot cross section was changed to triangular (Fig. 2b), which improved parting of the ingots, and the mass of the molds was increased. In order to increase durability, the mold was reinforced with steel bars, but this did not eliminate cracking and subsequent scaling of the mold due to filling of the cracks with iron.

There were periods when in a single shift 20-30 and even 60 damaged molds were replaced and 2.5 to 3 tons of scrap was welded onto the cones of the casting machines.

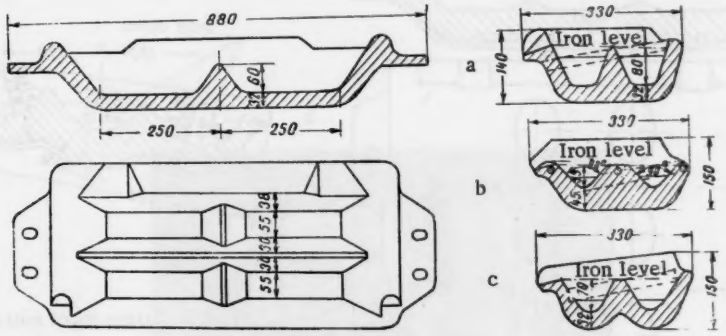


Fig. 2. Double ingot mold.

It was suggested that ingot hammers would permit the entire ingot to be extracted and would prevent scaling of the mold. However, the removal of ingots by blows from the pins of ingot hammers turned out to be inadequate: the molds broke and went out of order due to the blows. Nevertheless, the experience gained in use of the hammers indicated the correct path to the elimination of scaling – discover an efficient design and form for the mold.

A new double ingot mold of more even thickness (Fig. 2c) was used. However, its durability was not increased in comparison to previous molds; consumption of them decreased due to decreased weight. The quantity of scrap was also somewhat reduced.

In 1956 triple ingot molds were employed (Fig. 3), having a weight of 140 kg with an ingot weight of 25 kg

and a thickness of the mold housing of 25 mm. These molds had still lower durability; therefore, the mold housing was increased to 45 mm and the weight to 170 kg (Fig. 4a).

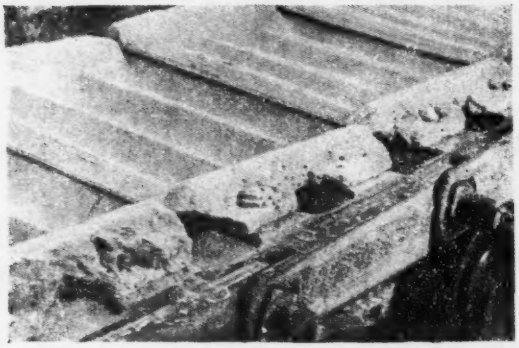


Fig. 3. Triple ingot mold on the belt of the charging machine.

Characteristics of Triple Ingot Molds

Features	Period of use	
	Jan., 1958 – Dec., 1959	Jan., 1960 – Jun., 1961
Weight of the mold, kg	210	225
Weight of the ingot, kg	24	18
Ratio of the weight of the mold to the weight of the iron cast	2.9	4.2
Durability of the mold, number of casts	3950	7220
Iron cast (per 1 ton of mold), tons	1360	1740
Scrap losses on the cones, %	0.3	0.3

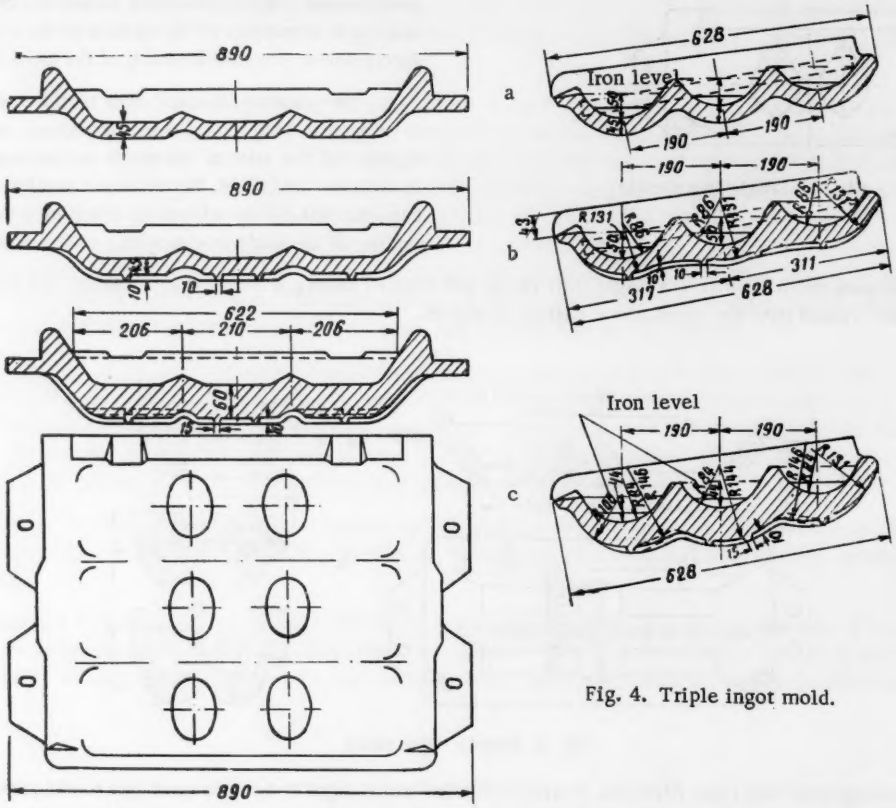


Fig. 4. Triple ingot mold.

In addition, to increase the durability of the molds, longitudinal and cross ribs were added on the outer surface, and the mass of the mold bottoms was increased. The weight of the mold was increased to 180 kg (Fig. 4b); the radius of curvature of the ingots was increased from 5 to 40 mm, since during loading the corners are broken off, resulting in an increase in iron losses through crumbling.

Later, the thickness of the mold housing was increased to 60 mm in the middle and somewhat less on the edges, thus raising its weight to 210 kg. With an ingot weight of 24 kg, this mold had the highest durability in proportion to

the number of casts and the amount of iron poured per unit weight of the mold.

At the end of 1959, the weight of the ingot was decreased to 18 kg (Fig. 4c) by reducing its thickness from 50 to 44 mm (the weight of the mold was increased to 225 kg).

Characteristics of the triple ingot molds of the two last types are given in the table.

The increased durability of these molds is explained by the high ratio of mold weight to weight of iron being cast and the more suitable form of the ingot cross section, which allows it to part easily from the mold.

One of the blast-furnaces of the Magnitogorsk Metallurgical Combine is served by a communist labor collective of which Viktor Vasil'evich Rodikov is foreman. Thanks to the creative initiative of the blast-furnace workers, the indices of performance are high. This reveals the great merit of the foreman, who efficiently organizes the labor and training of the collective.

V. V. Rodikov (left) and blast-furnace technical worker A. P. Prokhorenko.

Blast-furnace foreman V. V. Rodikov.

A communist labor crew of V. V. Rodikov. From left to right: second furnace attendant F. G. Svetlyakov, fourth furnace attendant V. I. Kazeikin, third furnace attendant E. A. Kalinin, foreman V. V. Rodikov, fifth furnace attendant Yu. M. Bashilov, first furnace attendant V. A. Ivanov (standing), scale-car machinist V. M. Ikryannikov, and gas fitter V. P. Tashlin.

IMPROVEMENT IN THE DEPHOSPHORIZATION OF METAL DURING THE MELTING PERIOD

V. F. Bogatenkov, O. Ya. Vainshtein, B. F. Zverev, and S. G. Firsov

Chelyabinsk Metallurgical Plant
Chelyabinsk Scientific Research Institute for Metallurgy
Translated from Metallurg, No. 11,
pp. 11-13, November, 1961

At the Chelyabinsk Metallurgical Plant during particular time periods when the phosphorus content of the iron reaches 0.16-0.18%, difficulty arises in dephosphorizing the metal to the necessary degree in the production of alloy steel in small-capacity open-hearth furnaces. The furnaces operate according to the scrap-ore process with a consumption of molten pig iron of 53-57%; they are equipped with basic arches and are fired with a mixture of coke-oven and blast-furnace gases. Oxygen which is fed through the tuyeres is used to intensify the thermal operation of the furnaces.

At the beginning, the necessary amount of iron ore is charged onto the floor, on top of this is charged 7-8.5% of the limestone, and then the iron portion of the burden; after preheating, the molten pig iron is poured in. One ladle of slag (11 m^3) is removed during the melting period; frequently it is drained off during finishing. Slag adjustment takes place during the last period.

During a sequence of ordinary heats, samples of the slag were taken at the beginning and end of its expulsion and during liquefaction of the metal. In addition, in order to determine the influence of the basic characteristics of the slag ($CaO:SiO_2$, FeO_{Total}, $CaO:FeO_{Total}$) on the phosphorus content of the metal during the melting process, a statistical analysis of 50 heats was carried out.

Basic Data on Heats of Various Types

Number of heat	Length of melting period, hr–min	Discharge of slag*		Slag drained from ladle	P_2O_5 in slag at tapping, %	P, %	
		beginning	end			in the iron	in the metal at tapping
			With modified charging order				
1	1—15	7	40	1/2	1.84	0.150	0.016
2	1—35	11	48	2/3	1.40	0.150	0.010
3	1—35	0	32	1	1.08	0.160	0.010
Average		6	40		1.44	0.153	0.012
			Without oxygen during charging and preheating				
4	1—55	19	52	3/4	1.98	0.176	0.015
5	1—40	24	62	1	1.78	0.150	0.007
6	2—30	6	39	1	1.56	0.157	0.010
Average		16	51		1.77	0.161	0.011
			With charging of dross before pouring in pig iron				
7	2—35	16	42	1	1.51	0.160	0.006
8	1—25	0	47	1/2	1.35	0.140	0.007
9	1—35	14	41	5/6	1.23	0.141	0.007
10	3—15	10	38	1	1.07	0.163	0.005
Average		10	42		1.29	0.151	0.006

* The beginning and end of slag removal are tabulated relative to the end of the charging of iron in percent of the total length of the melting period.

Three types of test heats were conducted. In the first (3 heats), oxygen was excluded during the charging and preheating periods; its consumption in the burner during melting was increased to 1400 m^3/hr, instead of 1200 m^3/hr as in ordinary heats. The order of charging the solid materials was not changed.

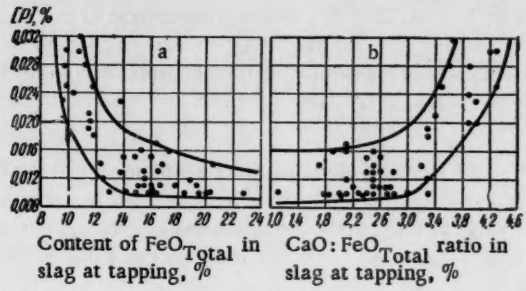


Fig. 1. Relation between the concentration of phosphorus in the metal at tapping and the content of FeO_{Total} in the slag (a) and $CaO:FeO_{Total}$ ratio (b).

In the second type (3 heats), fine iron (8-8.5% of the weight of the molten charge) was loaded onto the floor, followed by all of the limestone, and after the limestone – all of the ore. The thermal and oxygen regimes remained the same as during ordinary heats. The third type (4 heats) differed from ordinary heats only in that approximately 3 tons of dross was charged before pouring the molten iron into the furnace.

The quantity of limestone in the charge during ordinary heats amounted to 7%; the content of phosphorus in the iron – 0.12-0.14%. The characteristic feature of the extracted slag is its low content of iron oxides (an average of about 14% at the beginning and 12% at the end of removal). This occasions an insufficiently high content of P_2O_5 in it: on the average 1.37% at the beginning and 1.90% at the end of removal. The content of phosphorus pentoxide in the slag at the moment of tapping amounted to an average of 1.51% with a concentration of phosphorus in the metal of 0.011%.

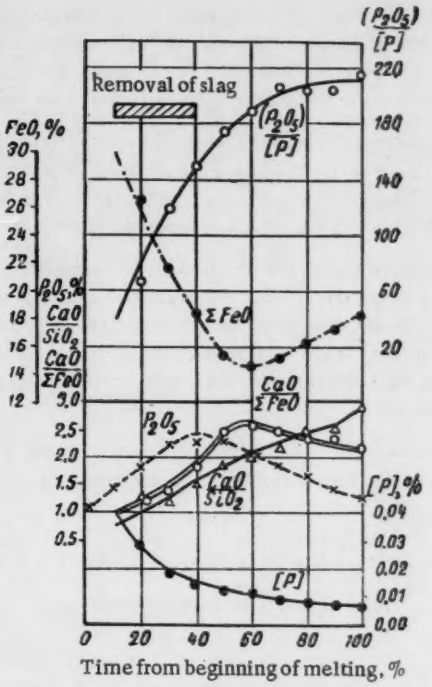


Fig. 2. Change in the chemical composition of the slag and the content of phosphorus in the metal during the melting period for heats in which dross was added before charging the pig iron.

The analysis of the data from the 50 heats established a relationship between the concentration of phosphorus in the metal at the moment of tapping on the one hand, and the content of FeO_{Total} in the slag and $CaO:FeO_{Total}$ ratio, on the other. In order to achieve a sufficiently low content of phosphorus in the metal at the moment of tapping (0.015%), it is necessary to have a $CaO:FeO_{Total}$ ratio not greater than 3 and a concentration of FeO_{Total} in the slag of not less than 13% (Fig. 1). With such values, the maximum coefficient of phosphorus distribution P_2O_5:P is ensured.

The basic data from the test heats are entered in the table, and the change in slag characteristics and phosphorus content in the metal during melting is shown in Figure 2. The curves are constructed according to average slag characteristics.

It is evident from the table that the content of phosphorus in the iron from all heats averaged 0.15-0.16%. A maximum concentration of phosphorus in the metal at tapping during heats of each type corresponds to a maximum content of P_2O_5 in the slag, and this corresponds, as a rule, to a minimum amount of slag removed during the melting period.

After charging the iron, the process of slag formation took place much more rapidly in those heats with a mod-

ified charging order. Because of this, the time interval between the end of pouring in pig iron and the beginning of slag removal is much shorter than in heats of the other types. Next in order of intensity of slag formation come the third and first types. The period of slag removal terminates according to the same sequence: after 40, 42, and 51% of the time length for the complete heat. The basicity of the slag removed during heats of the various types is practically the same and varies during the time of removal within the limits of 0.75-1.55. However, the content of iron oxides in the slag is different for every type. The maximum content of FeO_{Total} in the slag being drained off (30% at the beginning and 18% at the end) and the highest value of the coefficient of phosphorus distribution were observed in the heats in which dross was charged before pouring in the pig iron. The P_2O_5:P ratio of these heats increased as slag was removed from 40 to 150 (from 20 to 70 in the other types).

Dephosphorizing of the metal also went differently during the first half of the heat. At the moment that the removal of slag was finished, the concentration of phosphorus in the metal was a minimum in those heats in which dross was added before charging the pig iron (0.015%). The highest value of the P_2O_5:P ratio at the end of melting, due to increased basicity of the slag, was observed in the type where dross was added before the pig iron; this value was 210.

Because of the highest coefficient of phosphorus distribution P_2O_5:P in the heats where dross was added, the largest quantity of phosphorus was removed from the slag-metal system. With the same (as compared to other types) quantity of slag removed, in these heats the content of phosphorus pentoxide in the slag and phosphorus in the metal on tapping is noticeably lower than in heats of other types and amounts to 1.29% and 0.06% respectively. In heats of current production, the concentration of phosphorus in the metal on tapping amounts to 0.011%, and the content of P_2O_5 in the slag–1.51%.

Therefore, the best dephosphorization of metal during the melting period is provided in heats where dross is added before pig iron is poured in, due to an increase in the concentration of iron oxides in the slag being drained off.

INCREASE IN THE DURABILITY OF THE ARCHES OF THE OPEN-HEARTH FURNACE

M. G. Bryunetkin and A. A. Dobrokhotov

Chelyabinsk Metallurgical Plant

Translated from Metallurg, No.11
pp. 13-17, November, 1961

The open-hearth furnaces at our plant, which are fired with a mixture of coke-oven and blast-furnace gases with carburation by waste from the by-product coke industry, operate according to the scrap-ore process. In order to intensify heat transfer in the working space, oxygen is used in the burner and a supply of injection air is fed into the end of the gas conduit.

The upper 7-8 rows of air checkers are made of forsterite brick according to the "Couper" system, the upper 4-6 rows of the gas checkers–of fireclay bricks D-2, and the rest–of fireclay T-shaped brick according to the "Siemens" system with cell dimensions of 155x155 mm. The temperature of the checkers fluctuates from 1250 to 1350° (being at the maximum value on transfer). The vertical canals are made of chrome-magnesite brick, and the inclined part of the air canals (the arches of the air canals)–of heat-resistant MKh and PM steels.

The partitioning and cold walls of the slag chambers and part of the regenerators are made of Dinas brick with a facing of chrome-magnesite; the upper shoulders of the arches of the slag chambers, the cross arches, and 1 m of the arches of the regenerators –of magnesite-chromite brick measuring 300 mm; and the outer shoulders and arches of the regenerators–of Dinas brick.

The open-hearth furnaces are equipped with magnesite-chromite arches of stay bolt-hanger design with metallic linings between the bricks and with pin reinforcement against movement.

The intensification of combustion processes in open-hearth furnaces due to the utilization of oxygen has a double influence on service conditions of the arches. On the one hand, the temperature of the burner rises, and oxidizing

power increases, thus creating unfavorable conditions of service for the main arch. On the other hand, introduction of the oxygen stream into the burner permitted the arrangement of the burner to be improved and thus appreciably alleviated service conditions of the arch.

The durability of the main arches of the open-hearth furnaces at our plant increases from year to year as is evident from the following data (in heats):

Furnaces	Years			
	1957	1958	1959	1960
100-ton	558	574	576	698
185-ton	387	445	488	540

Improvement of the durability of the main arches is a consequence of the completion of a whole sequence of organizational-technical measures and better utilization of the furnaces, the principles of which are given below.

Light tamping of the joint during assembly of the arch permits the elimination of instances of the brick being ruined by tamping, and preliminary hanging before removal of the forms almost completely eliminates thermal stresses in the arch. This is confirmed by the fact that where formerly at the end of firing the arch had expanded by 25-40mm, after diminishing the tamping force this expansion was practically eliminated.

The correct choice of thickness for the coupling plates also has a large influence on the durability of the arch; in service the coupling plates oxidize, dissolve in the chrome-magnesite mass and form compounds having decreased heat resistance and temperature of start of deformation under load. The thickness of a zone of the oxidized plate changes according to the thickness of the brick and depends on the thickness of the plate. Whereas on the outer part of the arch it is an oxidized plate with remnants of the metallic part, in the middle part all of the metal (Fig. 1) oxidizes and combines with the brick mass. In the region of the inner zone of the arch, the plate dissolves completely and forms almost a single mass with the refractory. The thickness of the zone of the dissolved oxide in the middle part of the arch with a remaining thickness of brick of $\delta = 200$ mm with plates of 1, 2, and 3 mm amounts to 3-4, 5-6, 7-8 mm respectively.

Fig. 1. Fused metallic plate 3 mm thick along zones of the brick refractory of the arch.

It has been found by experimental tests that the most efficient thickness of the coupling plates is approximately 0.7 mm. Using this thickness, satisfactory burning-in of the arch and a limited zone of dissolved oxides are achieved. The use of plates greater than 1 mm leads to a reduction in the durability of the arch.

We should point out that at our plant and at practically all metallurgical establishments of the Union it is necessary to depart from the efficient thickness, and finish the collar by increasing the number of plates in it because of the lack of narrower types of brick for preparing the collar before tamping the joints.

It is expedient to have the hanger plates of somewhat greater thickness than the coupling plates; in using the latter with a thickness of 1 mm, slippage occurs if the arch is appreciably thick. Therefore, these plates have been used with a thickness 2-2.5 mm.

At the plant in the near future, testing of hanger plates made of stainless steel in order to reduce oxidation is planned.

The use of stronger suspension (like the type used in the NTMC) has appreciably improved the service conditions of the arch. The previously used type of suspension of VNIIO design (with hanger rods and stay-bolt pipes) had insufficient strength and could not be well regulated. It was possible to eliminate excessive stressing during expansion of the arch only by trimming the stay-bolt pipes, which in most cases is very hard to do.

Suspension of the type used in the NTMC gives stronger reinforcement of the arch, as a result of which the arch does not lose its shape until it is well worn. However, toward the end of a campaign, breaking away of the reinforcement of the suspension to the mounting and deformation of single units of the arch are observed, since the stiff, unregulated design of the suspension does not allow compensation for expansion of the arch due to thermal extension at the end of a campaign, and also because of the increase in the volume of the brick of the arch caused by the dis-

solving of the oxidizing plates. Moreover, none of the systems of reinforcing the arch permits even limitation of expansion, since it is beforehand very difficult to choose the clearance between the pipe and the mounting in the VNIIO reinforcement and the gap in the mounting of the reinforcement of the arch of NTMC design equal to the expansion of the arch.

Probably more efficient is the arch reinforcement of Stal'proekt design in which the thrust of the arch is realized by means of arched supports fitted to the inner contour of the fired arch and limiting expansion of its individual units.

At our plant, testing of such a design is intended with the use of elastic coupling of the tension arch with the furnace mounting through pressure springs.

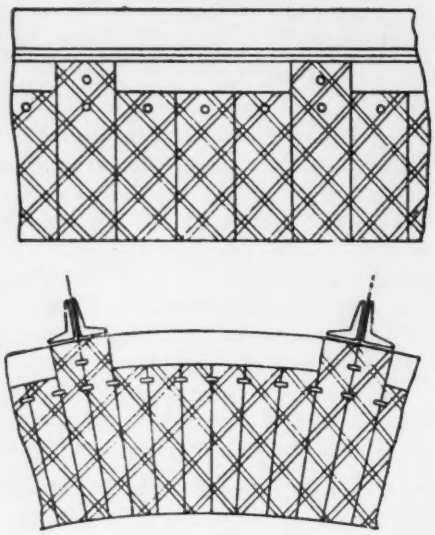


Fig. 2. Box-type arch.

Observations have shown that it is unsuitable to use corner irons for reinforcement which have shelves less than 90 mm high, since the strength of the iron is insufficient to absorb all the deformation of the bulging arch. It has become evident that corner irons with unequal sides are more suitable for reinforcement of the arch with the shelf of smaller dimension directly on the arch. In this case, with equivalent strengths of the corner irons, a smaller metal consumption is obtained, and also the arch is to less extent covered by the lower shelf of the iron, which is a dust collector.

In order to increase structural rigidity, the rise of the arch was increased from 1060 to 1175 mm on the 100-ton furnaces and from 1300 to 1450 on the 185-ton.

The angle of the supporting ledge for the abutment beams was increased to correspond to the increase in the central angle.

Observations have shown that beams designed with the special domes interfere with the cleaning of the arch. Large heaps of dust form in the vicinity of the front wall; this has a deleterious effect on the durability of the arch in this zone. In order to prevent the accumulation of dust, the domes on the beams have been eliminated, and the upper part of the beam has been situated approximately at the level of the upper edge of the arch. This permitted easier cleaning of the arch in this zone. The abutment beams are not observed to have burned through.

The fired refractories—MKhS, PShS, RPShS, unburned—BMKhS, and block—KRShS were used in the construction of the arch. The use of the unburned brick BMKhS provided 34% lower durability than the MKhS brick, and in spite of the reduced cost, they led to increased value of the steel. Lowering of the durability of the unburned brick occurred as a result of a reduction in its structural rigidity; it can probably be used efficiently only in furnaces with small arch span.

The periclase-spinel brick (PShS) showed 7-11% less wear than MKhS under service in the arch. However, the arch suffered heat loss at the beginning of the campaign 9%, and at the end of the campaign 3%, higher than when using MKhS brick. A technical-economic comparison of the performance of arches of MKhS and PShS bricks has shown that when operating with PShS brick, in spite of the increase in heat loss which expressed in monetary units amounts to 3.4 thousand rubles per year, a saving of about 4.6 thousand rubles per year on each furnace is achieved due to reduction in expenditures on repair of the arches (8 thousand rubles per year).

The durability of arches of RPShS brick does not differ from that of PShS arches.

The construction of smooth arches, as in the majority of plants, provides unsatisfactory rigidity toward the end of a campaign. At the plant, a more rigid, box-type construction has been tested (Fig. 2) in which, for protection of the hanger plates, bricks of larger size (460 mm) have been laid next to them. In addition, every fourth brick which is of larger size is made into a cross "Ortovskie" stabilizing rib, the protruding end of which is cooled from three sides. As a result, this construction of the arch has allowed prevention of overheating of the hanger plates until the arch is completely worn out, and it has, moreover, sufficient stability. Deterioration of the arches occurred with a remaining brick thickness of not more than 70-80 mm.

Comparison of the service of smooth and box-type arches has shown that the durability of the latter is an average of 8% higher, and the specific refractory consumption is 14.5% lower. However, cleaning of the arch is a very difficult and tedious operation, since "boxes" make blowing dust out of them difficult. Moreover, the process of assembling this arch is more involved, since the number of types of brick used is increased twofold, and strict alternation is necessary when placing them in the arch. After the introduction of an improved system of cleaning the arches by means of a blower-suction unit, tests will be conducted to determine the most efficient design of the box-type arch.

The durability of the arch is appreciably affected by the elimination of overheating due to the deposition of dust, which leads to an increase in the diffusion of iron oxides into the refractories; this lowers its performance characteristics. More intense expansion and deformation of the arch and overheating of the hanger plates also occur. At the plant, the arch is blown out every heat (during preheating); however, this is a difficult operation due to the high temperature and dust-filled atmosphere. In addition, 10-15 minutes are required for blowing-out with rapid completion of the process. Cleaning of the arch is forbidden during other periods by the rules of sanitation engineering.

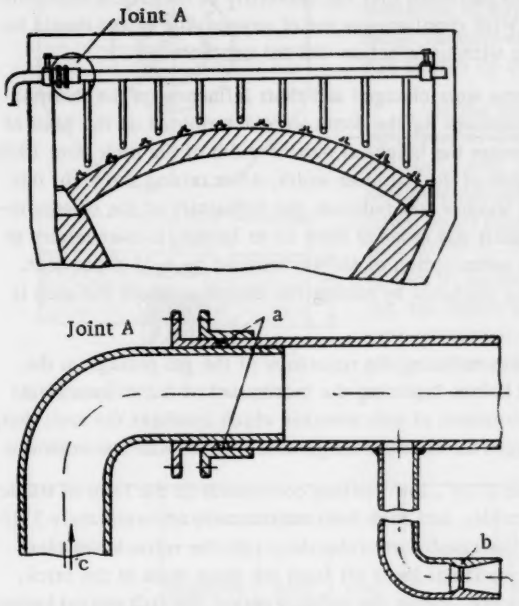


Fig. 3. Sketch of the mechanized, stationary apparatus for blowing out the arch: a) gasket; b) Laval nozzle; c) compressed air.

In order to improve working conditions, the blowing-out process was mechanized. On the arch were mounted compressed air tanks in which openings were cut and furnished with nozzles. All the tanks can revolve about an axis during which the direction of the nozzle is changed (Fig. 3). A steel worker, by turning on the tanks and rotating them, blows out the arch (turning on is done in sequence to prevent a drop in the pressure of the compressed air due to large output). In this manner, the arch is almost entirely cleaned, and only the corner irons of the suspension are blown out by hand. The entire operation requires 5-7 minutes, and the dustiness of the atmosphere is incomparably less.

However, such cleaning of the arch is not the best solution to the problem, since the dust removed remains in the atmosphere of the mill and eventually settles on some other units from which it must then also be removed. To improve the atmosphere and remove the dust from the mill, it is planned in the nearest future to clean the arches and other units by a blower-suction system; the dust-filled air will be sucked up into an exhaustor and expelled outside the mill.

Improved management of the flame has a large influence on the durability of the arches. The furnaces at our plant operate with a supply of oxygen to the flame. According to the plans, oxygen was fed into the flame by two tuyeres located at the sides of the caisson with an angle of inclination in a vertical plane of 8°. The angle of intersection of the oxygen tuyeres in a horizontal plane is 8°. The exit opening for the tuyeres was situated 300 mm above the bottom of the caisson. Such a mounting of the tuyeres anticipated feeding oxygen into the middle of the gas stream (at height of 600 mm) with the angle of inclination of the oxygen tuyeres parallel to the bottom of the caisson. Oxygen is supplied at the majority of the plants of the Union in this same manner.

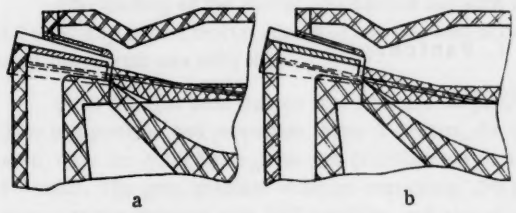


Fig. 4. Location of the zones of oxygen combustion: a) planned; b) used.

Observation of the flame with such an arrangement shows that the zone of oxygen combustion and the front of highest temperature are located in the upper part of the flame (Fig. 4). Heat flow to the hearth decreases, but that to the arch increases. In order to eliminate this shortcoming, the angle of inclination of the oxygen tuyeres was increased to 12°, and the focus of supply was lowered to 200 mm above the bottom of the caisson.

For reducing lamination of the flame and earlier introduction of oxygen into the gas stream, the angle of intersection of the oxygen streams was increased by moving the rear ends of them 150 mm further apart. The angle of intersection was thus increased from 9 to 13°. This alteration permitted shifting of the high temperature zone of oxygen combustion toward the lower portion of the flame (Fig. 4b), concentration of the flame such that the duration of a heat was reduced an average of 4%, and increase in durability of the arches.

To improve the stability of the flame, compressed air is supplied to the end of the gas stream through injectors; the air burns part of the gas in the conduits and improves management of the flame. The flame is in this case more discrete and stable, since the eddies of turbulent pulsation are smaller in scale.

The indicated improvement in management of the flame contributes to increased durability of the arch. A comparison of the durability of arches with and without air injection indicated that the durability of magnesite-chromite without utilization of oxygen was 11% higher in the first case. With simultaneous use of oxygen, the effect should be somewhat reduced, but prolonged industrial testing of operation without injection was not conducted.

During furnace operation, the basic dimensions of the dome were changed and their influence on the thermal regime and durability of the main arch analyzed. Efficient dimensions for the dome were determined on the basis of the results obtained. In using oxygen, it is not expedient to increase the height of narrow width of the arch from 1950 to 2200 mm, since with smaller size wear is observed in the region of the narrower width. After raising the arch, this unevenness was eliminated. In addition, the width of the firing window was reduced, the diffusivity of the caisson increased, and the angle of inclination of the arch of the gas conduit was reduced from 15 to 12-13°. It is necessary to reduce the width of the charging window by 10-12%, since the consumption of air was reduced by 8-15% per heat. Thanks to this, the increase in cross section of the firing window produced by raising the narrow width of the arch is eliminated.

It is effective to increase the diffusivity of the caisson, thus reducing the resistance of the gas passage in the dome and contributing to the formation of a more manageable flame. Reducing the inclination of the caisson from 14-15 to 12-13° lowered the "crushing" of the flame and the formation of exit vortexes which overheat the arch along the front and back walls. With this, approximately even wearing of the arch both lengthwise and crosswise was achieved.

Observations have shown that with overheating higher than 1750°, low melting compounds in the form of stalactites begin to melt from the arch; they contain over 20% iron oxides, and their heat resistance is approximately 1710-1730°. In addition, during overheating of the arch an intense diffusion of iron oxides deep into the refractories takes place, and an inner layer rich in iron oxides quickly develops, partitions itself off from the main mass of the brick, and upon future cooling this layer spalls off more rapidly. Therefore, during the refining period, the arch was not heated over 1730° due principally to improved slag release and operation with an easy forming, basic, thin cover of slag. Improvement of the thermal conductivity of the slag is the main and most efficient means for lowering the temperature of the arch during refining.

THE REPLACEMENT OF CAST STEEL STOPPERS BY CERAMIC REFRACTORIES CONTAINING GRAPHITE IN THE TOP-POURING OF STEEL

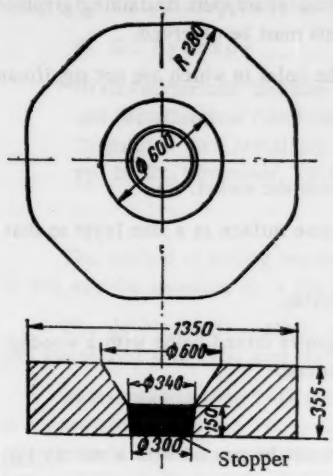
A. S. Zhikharevich, A. G. Karaulov, B. I. Panich,

I. I. Sheiko, V. F. Polyakov, S. F. Khalemskii

Translated from Metallurg, No. 11,
pp. 18-19, November, 1961

At the Malyshev Plant cast steel stoppers used to be used in the pouring of killed steel ingots to protect the bottom plate from erosion by the stream of liquid metal and to prevent the ingots' sticking.

The use of cast steel stoppers entailed an increase in the cost of the steel: with a consumption of stoppers equal to 8 kg/ton and a cost of 120 rubles/ton, the cost price is increased by 8 x 12 = 96 kopeks/ton; moreover, the task of producing the stoppers falls on the foundry shop. The steel stoppers have to be carefully installed, and in particular the gap between the bottom plate and the stopper has to be densely packed with asbestos. This makes the operation difficult and does not always guarantee against escape of metal.



Malyshev Plant bottom plate.

At the experimental factory of the Ukrainian Refractories Institute, stoppers containing graphite designed for repeated use were prepared. Stoppers from ceramic substances containing graphite have a high corrosion resistance because of their low wetability by metal. They also have increased hot strength and a high thermal conductivity to ensure the required crystallization rate so that the formation of shrinkage cavities in the bottom part of the ingot is prevented. Ceramic stoppers also have adequate mechanical strength; the resistance to shock and erosion by the action of the metal stream during pouring depends on this.

For the tests, stoppers were chosen which contained 15-50% graphite and were fired at a temperature of either 1320° C or at a lower temperature (550° C) to remove only water of crystallization. The composition and properties of the experimental stoppers are shown in the table. Trials were carried out in pouring killed steels (steels 20, 35, 40, 45), the metal temperature during pouring being 1650-1670° C. The steel was poured from a single stopper ladle through a nozzle 35 mm in diameter, the height of the stream's fall being about 3 m. After casting, the ingots were kept in the ingot molds for not less than a day. The stoppers were covered with a thin layer of mortar and inserted into the holes of single-place bottom plates (see figure), onto which were placed open-ended big-end-up ingot-molds for casting 10-ton ingots.

Composition and Physico-Chemical Properties of Stoppers Containing Graphite

Stoppers	Stopper composition, %			Density, g/cm³	Apparent porosity, %	Compression strength, kg/cm²	Refractoriness, °C	Thermal conductivity in vacuum, kcal/m·hr	Deformation temperature under load, °C	
	graphite	grog	clay						initial	for 4%
Graphite-clay	50	–	50	1.76	26.2	76.9	1950	20.5	1440	1550
Graphite-grog, fired	40	40	20	1.77	25.8	108	1950	13.5	1420	1500
The same	15	35	50	1.93	21.1	274	1770	5.0	1400	1470
Graphite-grog, unfired	40	40	20	2.03	20.9	103	–	–	–	–
The same	15	35	50	2.16	18.7	119–140	–	–	–	–

The mortar used in installing the stoppers had the following composition: 30% flake graphite, 30% Ch-1 clay, 40% grog from Ch-1 clay (grain size less than 1 mm).

The binding of the mortar was carried out with water with the addition of 10% water glass having a modulus of 2.7-3.0. Any excess mortar squeezed out was carefully removed. Then the bottom plates were dried with gas burners until the mortar was fully dry.

Even the first tests showed that it would be possible to use the stoppers being tested repeatedly, regardless of their composition and properties. After 3-4 casts, the working surface of the stopper is to all intents and purposes unworn, only the color having changed (reminiscent of a temper color). Stopper wear begins to be apparent only after 6-7 casts. The grog-graphite stoppers containing 15% graphite exhibit a very long life (up to 43 casts). The life of grog-graphite stoppers with 50% graphite, and also of unfired stoppers (15 and 40% graphite) turned out to be markedly lower and was in all 15-18 casts. They went out of service chiefly because of gradual break-up of the surface from the impact of the stream.

During the tests, the carburized layer of metal in contact with the surface of the stopper was investigated. The results of chemical analysis demonstrated the absence of any marked increase in carbon content in this layer. Macrostructural study showed that the bottom parts of ingots with stoppers containing graphite are typified by a dense macrostructure without traces of shrinkage cavities or any other defects.

In this way, as a result of the trials that have been carried out, it has been established that a graphite content of 15% fully guarantees the stopper's adequate hot strength and low wetability, thus creating the conditions for their long life (a low graphite content is desirable from economic considerations). The use of stoppers containing graphite has shown, however, that to ensure long service a number of technical requirements must be observed:

1. Stoppers must be installed in new bottom plates preheated beforehand, the holes in which are not significantly elliptical and also have no ridges or concavities.

2. The stoppers must not have cracks on the corners and working surface.

3. To avoid entrapment, the upper part of the stopper should not protrude from the socket.

4. The mortar should be of a creamy consistency, and should be put on the side surface in a thin layer so that the joint thickness should not exceed 1-3 mm.

5. The stopper should be quickly positioned to avoid solidification of the mortar.

6. Immediately after being positioned in the socket, the stopper should be gently driven home with a wooden rammer, and any remains of mortar that are squeezed out should be carefully removed.

7. The bottom plate may be used only after the mortar has fully dried.

8. To avoid erosion of the bottom plate around the hole perimeter, ingots should be poured with a strictly centralized stream, so that the stopper should directly take up impacts from the stream.

Installation of stoppers with this technique boosts their average life to 45-48 casts. Now one stopper is sufficient for the working of one bottom plate until it goes out of service. At the present time, in the melting shop of the Malyshev Plant, all the large forge ingots are cast with the use of grog-graphite stoppers.

THE ROLLING OF 7-9 TON INGOTS BY THE SEMI-TWIN METHOD ON A 1150 mm SLABBING MILL

I. Ya. Tarnovskii, Yu. I. Odinokov, G. G. Kustobaev, and B. D. Sychkov

Urals Polytechnic Institute, Institute of Ferrous Metals and Metallurgical Combine (MMK)

Translated from Metallurg, No. 11, pp. 20-22, November, 1961

The method of rolling two ingots successively makes it possible to increase a mill's productivity considerably. In this way the speeding up of the process is achieved by reducing the time taken in moving the upper roll.

The slabbing mill at MMK consists of two stands: the first (in the rolling direction) with 900 mm vertical rolls, and the second with 1150 mm diameter horizontal rolls.

At the present time 7-12 ton ingots are rolled on the slabbing mill and the rolling of ingots weighing 21 tons is encountered. In rolling 7-9 ton ingots the productivity of the slabbing mill is of course reduced. The use of twin rolling would make it possible to increase the hourly production capacity of the slabbing mill. However, implementation of this method on the slabbing mill at MMK was difficult because of the inadequate length of the live tables, and also because of the possibility of feeding two workpieces with overlapping at small thickness; this could lead to serious trouble.

TABLE 1. Principal Details of the Rolling of 100 x 1010 mm Slabs by the Semi-Twin Method

Item	Pass number																		Figure for cycle
	1a 1b	2a 2b	3a 3b	4a 4b	5a 5b	6a 6b	7a 7b	8a 8b	9a 9b	10a 10b	11a	12a	13a	11b	12b	13b	14b	15b	
Space between horizontal rolls	1060	1025*	550	505	455	410	362	320	260	220	180	140	140	220	180	152	140	140	—
Reduction in pass (horizontal stand), mm	40	35	40	45	50	45	48	42	60	40	40	40	—	—	40	28	12	—	—
	In horizontal stand																		
Machine time (for mill), sec	0.7	0,7 0,8	0.8	3.1	3.0	2.9	3.4	3.3	3,9	4.3	4.9	2.9	3.65	3.1	2.4	3.2	3.45	3.45	3.3	57.15
Pause (after pass), sec	2,9+ 1.5**	7.4+ 0.8**	2.6	1.6	2.4	2.3	1.7	0,0	2.5	0.0	1.93	2.6	5,9	2.15	0.0	1.85	1.9	9,8		49.45
Total time of pass, sec	5.8	9.8	5.6	4.6	5.3	5.7	5.0	3,9	6.8	4.9	4.85	6.15	9.0	4.55	3.2	5.3	5.35	13.1		108.9
Heat loading of motors, %																				
1D and 2D	29.6	26.4	44.0	56.0	79.0	66.2	86.0	85.5	101.2	73.0	87.0	73.8	31.8	26.5	75.3	59.0	34.7	28.6		59.2
3D	33.4	68,5	52,7	53.0	51.0	48.1	53,5	55,0	81.0	70.5	63.5	40.5	37.5	38.7	53.0	75,0	52.7	37.8		53,6

* Tilted after pass.

** Time between delivery of the first and entry of the second ingot. In flat passes, the rolling of the second ingot in the vertical rolls overlaps with this. The space between the rolls is 1018 mm.

Then it was proposed that ingots of this weight should be rolled by a semi-twin method: up to a determined workpiece length, the ingots are rolled by the twin method, and then each ingot is rolled separately. In connection with this, a complex investigation was carried out of the working of the slabbing mill with the single and semi-twin methods of rolling; the objects were to elucidate the loading of the main motors of the horizontal and vertical rolls with the increase in machine time and to develop a speed schedule which would ensure normal working of the motors*. The oscillograph technique was the chief method of investigation.

TABLE 2. Comparative Details for the Rolling of Ingots by the Single and by the Semi-Twin Methods

Details	Type of ingot	
	UNS, 8.6 tons	UNS, 7.05 tons
Dimensions of rolled slab, mm	100 x 100	140 x 750
Number of passes	13 / 18	11 / 14
Length of rolling cycle, sec	71* / 109	66.1* / 95.2
Machine time, sec	34 / 57	31.8 / 50.2
Pause length, sec	37 / 52	34.4 / 45.0
Heat loading of motor,%: horizontal stand	49.4 / 59.2	50.7 / 61.1
vertical stand	51.3 / 53.6	52.7 / 53.1

Note. Figures for single rolling are given in the numerator, and for semi-twin method in the denominator.

* Figures obtained in demonstration rolling.

In single rolling, the pause from the forward side of the mill in many passes was equal to zero, but gripping from the rear side was achieved at a speed of 15-20 rpm. In this case the root-mean-square current loading on the motors averaged 50-55%.

Rolling ingots by the semi-twin method with the same speed schedule and with the reductions distributed in the same way among the passes led to individual "hard" passes. Thus in the even passes with minimum pauses, the rms current overloading of the horizontal stand motors reached 165%, averaging 85% for the cycle.

With the speed schedule newly developed for rolling by the semi-twin method, the gripping of the ingot and rolling are carried out at a constant maximum speed and this ensures a reduction in the moments of the motors and creates much more favorable conditions for their working. The chief details about the passes in rolling 8.6 ton ingots with the new speed schedule are shown in Table 1.

The twin rolling of the ingots is carried out in ten passes. Thus the gripping of the first ingot of a pair takes place at the maximum speed. The speed at which the second ingot is gripped approximates to the speed at which the first leaves (49-52 rpm). Finishing rolling is carried out with the same speed schedule as in the rolling of single ingots.

It cannot be maintained that such a speed schedule for twin rolling is the most rational; however, it makes it possible to increase the mill's productivity by 30-35% and is favorable to normal working of the motors. Moreover, it ensures that overloading of the motors to overheating is eliminated. In the twin rolling cycle, the rms current for motors 1D and 2D is 4230 amp, i.e., 63.7%.

Figures are presented in Table 2 which show the effectiveness of rolling 7-8.6 t ingots by the semi-twin method in a 1150 mm slabbing mill.

In rolling with the new method, the machine time taken in rolling one ingot is reduced. The fraction of machine time in the whole cycle of rolling one ingot is increased. This is also connected with the fact that a system of control by the voltage of generators does not ensure stability during the take-up of loading since there are large delays in its action. There are therefore significant drops in speed and these cause the average speed to be reduced to 46-47 rpm and cause the machine time to be increased.

An investigation of the dynamics of twin rolling has shown that, in spite of established opinion, impacts upon gripping the second ingot in the principal direction, both with the established as well as with the transitional schedule, are absent, although impact loadings are easily registered on the oscillograph screen. The gripping of the second ingot went on smoothly without hazards with absolute reductions of up to 85 mm.

The oscillograph study of twin rolling shows that the speed schedule is not adequately developed: there are con-

* G. A. Brichko, S. G. Spiridonov, D. I. Medvedev, Ya. V. Duvakin, A. N. Rakitin, V. V. Fominykh and V. S. Kuz'minykh took part in the investigation.

siderable periods (0.3-0.7 sec) when the motors are working at their maximum speed before gripping and after delivery.

The chief time gain in the twin rolling cycle is obtained by reducing the working time of the screw-down installation, and this is especially true in rolling wide slabs with edging passes—that is, when there are considerable movements of the upper roll. There are also gains from reducing the time taken in tilting.

Further increase in slabbing mill productivity may be achieved by entirely cutting out periods of working at maximum speed before gripping and after delivery. In all the passes after which there is no tilting the speed at delivery of the second ingot should be reduced. This will lead to a certain reduction in motor loading and to a shortening of pauses.

ROLLER GUIDE EQUIPMENT FOR ROLLING MILLS

V. G. Drozd, P. I. Tetel'baum, and I. F. Prikhodko

VNIIMetmash (All-Union Scientific Research Institute for Metalworking Machinery) and the Élektrostal' Heavy Machine-Construction Factory
Translated from Metallurg, No. 11,
pp. 22-25, November, 1961

The guide equipment of rolling mills can be classified under three heads, namely, position with respect to the working stand (entry or delivery), method of construction, and the type of friction between the workpiece and the working elements of the equipment (sliding or rolling).

Recently a preference has become apparent for rolling friction equipment, which has a number of advantages as compared with sliding friction equipment; it contributes to an improvement in the surface equality and accuracy of the finished rolled product, and also to an increase in the productivity of mills because the roll operatives' work is made easier and setting-up time is shortened. Moreover, they give more prolonged service and contribute to a reduction of energy consumption in rolling, especially in tilting large profiles in continuous mills, and also favor a smaller consumption of guide equipment per ton of finished rolled product.

Rolling friction equipment (usually called roller equipment) ensures the rapid and accurate adjustment of the working elements. Setting it up rigidly takes not less than 3-4 hours of mill time. Contact of the equipment with the moving workpiece is carried out through rollers, operating with rolling friction. Only by means of rollers is it possible considerably to increase the wear-resistance of the working elements of the equipment, to enable them to remain rigidly set up for a longer time and to reduce the possibility of scratches, laps, score marks and other defects arising on the rolled product.

The construction of the equipment is carried out with sufficient strength to withstand the frequent blows from the workpieces being rolled; these move at great speeds. The presence of safety components makes it possible to protect the more costly parts, which are seldom replaced. This is especially necessary in the delivery guide, where there are frequent instances of the ends of the workpiece jamming as they come out of the rolls; its construction should therefore make it possible to withdraw jammed workpieces quickly.

The set-up of a piece of modern rolling friction equipment with mechanized movement along the roll flank is shown in Fig. 1.

In Fig. 2a, entry roller equipment for ovals is shown; this is used in a semicontinuous 250 mm small-section mill. Good gripping of the workpiece is achieved with the roller dimensions a minimum as to diameter and height; this makes it possible to situate them very near to the working zone of the groove. The same guide is also used for the entry of squares. In this case the rollers are no longer provided with a rhombic, but with a rectangular groove. The material for the rollers is steel 55Kh.

Entry guides with an elastic roller installation (by means of a coil spring) are planned, following the same type, for a 250 mm continuous mill. It was shown in testing them that they gripped the oval in the groove well; however,

entry of the workpiece into the guide was difficult at a speed of 12-15 m/sec. The height of the first pair of rollers was then increased in comparison with the rollers next to the working rolls, and the workpiece began to enter freely.

In this connection it should be noted that there are examples in the literature of the use of roller guides in which the roller height is less than the height of the workpiece; in this case, they were not a success. Since an elastic roller installation did not produce any advantages in rolling soft metal, a spring was no longer installed.

Bringing the tilting rollers of the delivery guide as near as possible to the working rolls (Fig. 2b) makes it possible to reduce their angle of taper for the same angle through which the workpiece is tilted; this facilitates the entry of the leading edge of the workpiece into the rollers. This is especially important at high rolling speeds.

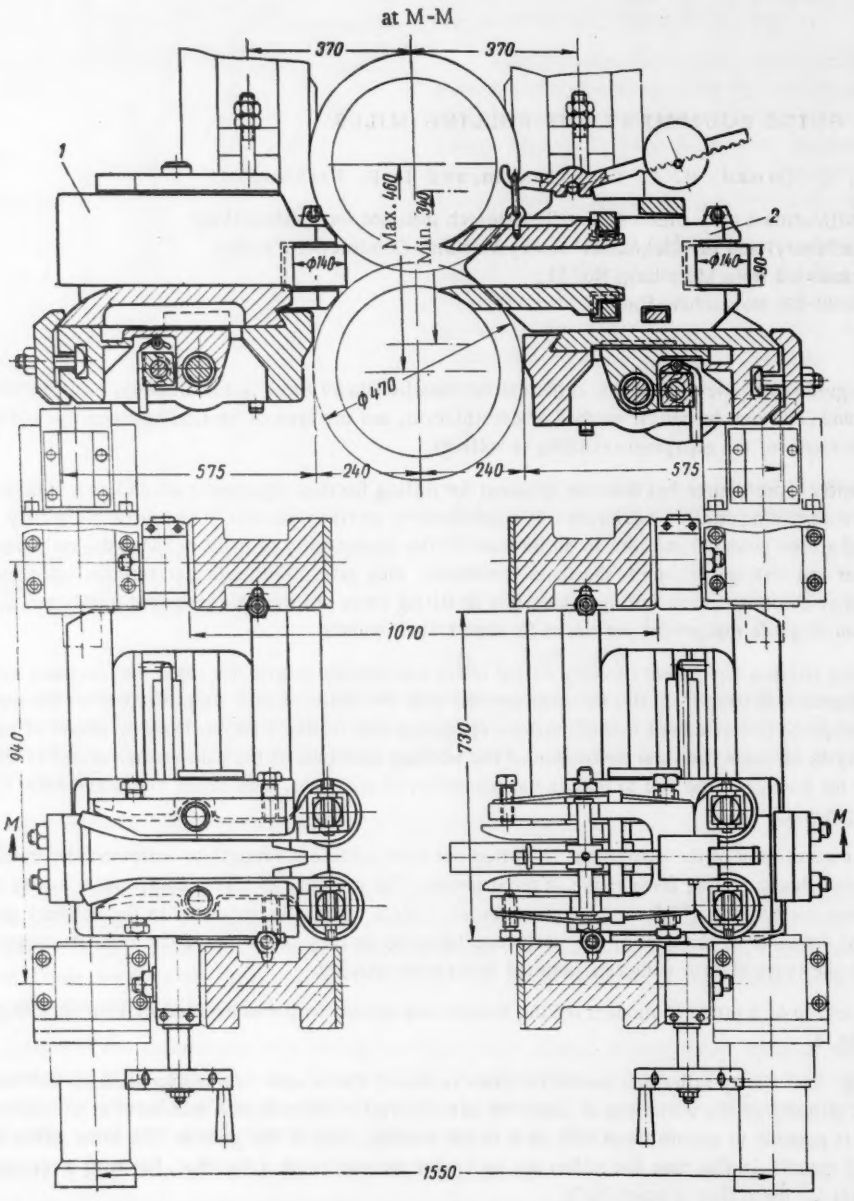


Fig. 1. Rolling friction equipment on the working stand of a 300 mm medium section mill. 1) Entry equipment; 2) delivery equipment.

The angle of tilt is regulated by positioning the height of the upper roller with the aid of aluminum packing pieces. By their use (Fig. 2b) the guide is protected to a certain degree from accidents, since, if the product being rolled jams between the rolls and the guide, the packing gives way and the guide is torn off from the rest-bar.

The body of both guides is used for supplying water to the groove in the lower roll and to the guide rollers.

In planning roller guides, minimum roller dimensions should be used, since this makes it possible to bring them as near as possible to the rolls' working zone. This ensures that workpieces are better restrained from breaking out, and also the rollers' moment of inertia is reduced, thus reducing resistance during the entry of the workpiece into the guide.

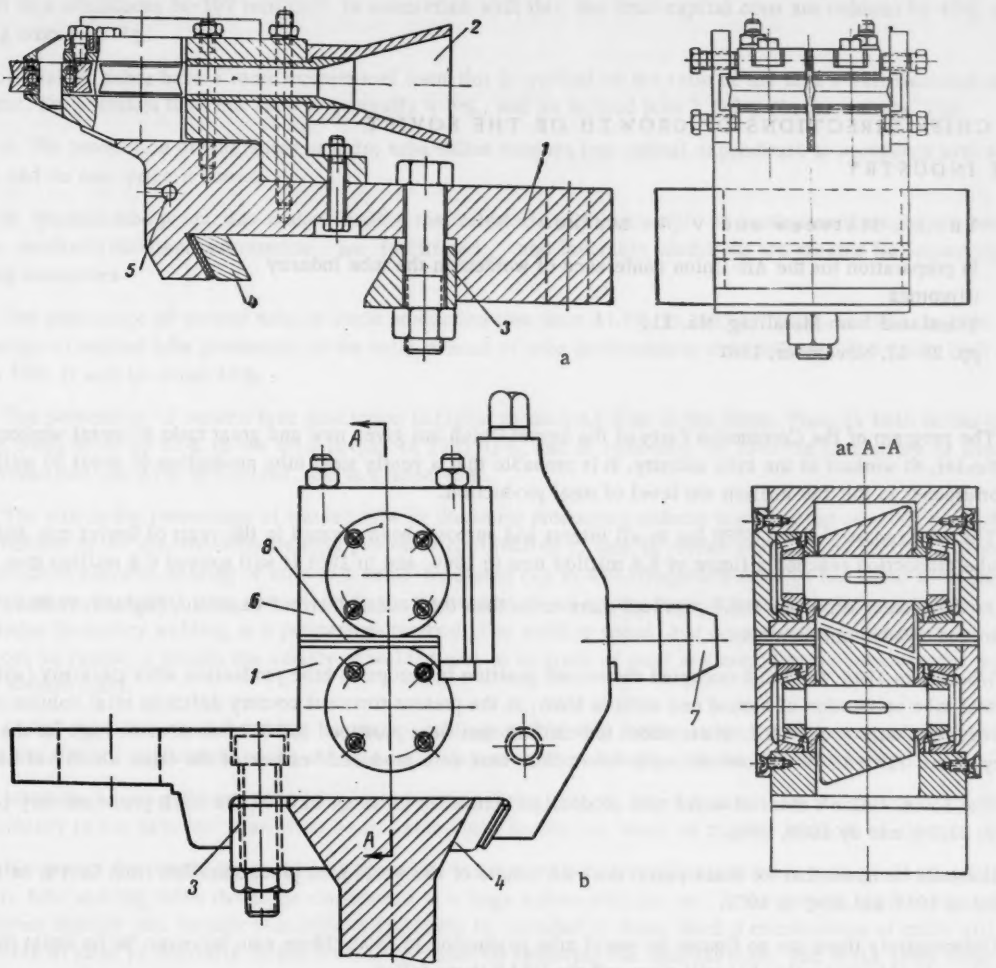


Fig. 2. Rolling friction equipment for a prefinishing oval (finished section, 9 mm diameter round). a) Entry guide; b) delivery guide. 1) Body; 2) receiving funnel; 3) securing wedges; 4) aluminum packing pieces; 5) aperture for water supply; 6) upper roller housing; 7) receiving tube; 8) adjustment packing.

On the other hand, reducing the roller diameter leads to an increase in its speed of rotation at the same workpiece speed, and this reduces bearing life. However, the installation of larger diameter rollers, even with a small height, leads to breaking-out of the oval or even to the oval's missing the groove because it is bent in the section between rollers and rolls.

Experience in the working of high speed section mills indicates that 60-75% of stoppages in the working of the major equipment arise from inadequacies in the construction of ancillary equipment. This is especially felt in the starting of new continuous mills. However, the ancillary equipment for rolling mills is usually prepared in metallurgical factories in the repair or machine shop. It is to be deplored that no centralized and systematic work is carried out on the improvement of the construction and quality of rolling mill ancillary equipment.

When account is taken of the experience abroad, especially in Sweden, in supplying rolling mills with ancillary equipment, it must be acknowledged that it is desirable to set up a specialized undertaking to produce guide equipment both for any new and for existing rolling mills.

THE CHIEF DIRECTIONS OF GROWTH OF THE SOVIET TUBE INDUSTRY

Yu. M. Matveev and V. P. Markov

In preparation for the All-Union conference of workers in the tube industry
Gipromez
Translated from Metallurg, No. 11,
pp. 25-27, November, 1961

The program of the Communist Party of the Soviet Union has given new and great tasks to metal workers, and in particular, to workers in the tube industry. It is probable that a yearly steel tube production of about 30 million tons corresponds to the 250 million ton level of steel production.

The tube industry of the USSR has to all intents and purposes been created in the years of Soviet rule and the steel tube production reached a figure of 5.8 million tons in 1960, and in 1961 it will exceed 6.4 million tons.

At the present time, the USSR produces more tubes than the Federal German Republic, England, France, Italy, Belgium and Sweden put together.

Whereas in 1940, the USSR occupied the second position in Europe in tube production after Germany (with a total steel tube production of around one million tons), at the present time our country defers in total volume of steel tube production only to the USA, where about ten million tons were produced in 1957 (an all-time high for the tube industry of the USA); in 1958, however, only 6.6 million tons were produced because of the crisis which had begun.

The Soviet Union's share of world tube production is steadily growing: in 1937 the USSR produced only 13.8%, in 1957, 20.5% and by 1959, 28%.

It should be noted that for these years, the USA's share of the world tube production fell from 52.4% in 1937 to 47.2% in 1957 and 32% in 1959.

Unfortunately there are no figures for world tube production in 1960. There can, however, be no doubt that the USSR's share in this production has still risen and the USA's share fallen.

The USSR's tube production is growing at a rate in advance of other sectors of ferrous metallurgy. The ratio of tube production to rolled product production is steadily rising. This ratio stood at 7.4% in 1940 and by 1958, 10.8%. In 1957, this figure was 13.4% for the USA, and in 1958, 11.2%.

The average yearly increase in tube production in the period from 1955 to 1960 was 11%. World tube production in this period increased by 5.9%, which corresponds to an average yearly growth in all of only 1.5%. However, in these years, steel tube production in the capitalist countries of Europe rose by 18%, which corresponds to a yearly growth of 4.5%. In connection with the general crisis, tube production in the USA was reduced by approximately two million tons, or 22%.

In the post-war period, the concentration of tube production in the USSR has risen considerably. Thus, the tube output at one factory in 1940 was 68 thousand tons, and in 1960 more than 300 thousand tons.

As is well-known, steel tubes are divided according to their method of manufacture into seamless (produced by rolling or extrusion) or welded (obtained by various welding methods). There has been a wide growth of welded tube production both in the USSR and abroad, and this is connected with its present technical and economic advantages. The advantages are the following:

a) The shape-change in welded tube production (forming a flat billet into a tube) requires less expenditure of energy than tube production by the seamless method (piercing a hole and subsequently cross-rolling the tube-billet). Because of this, there is a reduction in the entire equipment and its power, as well as in the specific capital outlay and running cost. Thus, for example, in producing tube by resistance welding on a continuous 20-102 mm mill, almost half as little equipment is required per ton of tube production compared with producing tube by the seamless method in a continuous 30-102 mm mill. In connection with this, the total capital costs are reduced by 43% and the running costs by 6.7%.

b) Welded tubes have a more economical form; this is typified by the ratio of the tube's wall thickness to its diameter. For seamless tube this ratio is generally 4-5%, and for welded tube 1.5-2% (in some cases, 1%).

c) The production of flat (sheet or strip) tube-billet requires less capital expenditure as compared with round billet, and its cost-price is lower.

d) Welded tube production makes possible the fullest use of the principle of continuous through-put; because of this, mechanization and automation are facilitated, and favorable conditions are created for improving the working conditions.

The percentage of welded tube in world production rose from 47.8% in 1937 to 52.2% in 1957. In 1940, the percentage of welded tube production in the total volume of tube production in the USSR was 32.8%, in 1960 42.5%, and in 1961 it will be about 46%.

The percentage of welded tube production is higher in the USA than in the USSR. Thus, in 1940 in the USA welded tubes made up 53% of the total output, in 1957 61%, and in 1958 66%. In 1957 the percentage of welded tube production was 57% in England, and in France 48%.

The rise in the percentage of welded tube in the world production volume is still going on to-day, and further improvement in the electric tube welding process is contributing to this. In recent years, a new method of contact and induction electric welding of tube with radio-frequency (up to 450 kilocycles) currents has found wide use. On the basis of experimental work carried out in the Soviet Union and on the basis of foreign experience, one may consider radio-frequency welding as a progressive method. The welding speed, and consequently productivity of mills as well, can be raised; it widens the variety of welded tube as to grade of steel and considerably improves the quality of the welded joint.

In this way, the use of the radio-frequency welding method still further raises the economic advantages and widens the field of application of the electric welding process as compared with the seamless method.

What has been said above forms the basis for considering that the chief direction for the growth of the Soviet tube industry in the next few years must be in welded tube production based on modern methods of electric welding.

Because of the possibility that has appeared of widening the variety of welded tubes as to grade of steel, new electric tube welding mills should be constructed to a large extent with the use, in the process, of the principle of continuous through-put. Stretch-reduction mills should be included in them. Such a combination of mills will make it possible to raise productivity, make conditions easier for removing the internal flash, and at the same time as this it will lead to the normalizing of the electric welded tube in the process of making it.

For making tubes which are difficult to form in the cold condition, or which cannot be formed in this way because of special customer requirements, as well as this there should also be further development in the production of steel tubes by the seamless method, but to a smaller extent than in previous years.

The 140, 250 and 400 mm tube rolling mills, widely used up till now, which work on thin-walled tube billets obtained by spiral piercing with subsequent cross-rolling on a fixed mandrel, appear to be obsolete in modern conditions. By its very nature, tube production on this type of mill tends to the formation of flaws and scratches on the tubes' inside surface, and the removal of these is very expensive. Moreover, these mills make it impossible to use a complex automatic process. Therefore, further technical development of seamless tube production in the next few years should be along the lines of replacing, as far as possible, the method of piercing on spiral-rolling mills by the compression of tube billets into tube by cross-rolling in continuous mills working with a floating mandrel.

Stretch-reduction mills with a large degree of reduction should be used for the production of small and medium diameter tubes.

For rolling ball-bearing and other thick-walled tube to an increased degree of accuracy, there should be further development of three-roll cross-rolling mills, and these should be used with straight through annealing furnaces, in which the rolling temperature is used for the requirements of heat-treatment. This will make it possible to cut out the costly operation of skimming the finished tubes tc remove the decarburized layer.

The use of the principle of continuous through-put in the electric welding and seamless methods of tube production will make it possible to carry out welding and rolling at speeds higher than those possible in former installations. Thus, for example, on continuous mills (plant with automatic mill), and also on electric tube welding mills using radio-frequency welding (contact resistance welding mills) the maximum rolling speed for the production of small diameter seamless tubes may be increased from 5 to 12 m/sec.

The wide use in tube production of the latest achievements in electric welding and the creation of continuous tube rolling mills will make it possible markedly to increase the quality of steel tubes, widen their variety, cut down on capital expenditure and reduce production expenses.

Together with the use of new types of tube mills for electric welded and seamless tubes, in the next few years the energies of scientific-research and planning-construction organizations should be directed to the study, in principle, of new processes, as, for example, getting steel tubes directly from liquid metal and so on.

DEVELOPMENT OF THE PRODUCTION OF HIGH-STRENGTH CAST-IRON PIPES

V. G. Shiyan and V. A. Davydov

Ukrainian Scientific Research Institute for Pipes
Translated from Metallurg, No. 11,
pp. 27-29, November, 1961

The Seven-Year Plan for the development of the national economy of the USSR has placed before pipe casters the task of increasing in 1965 the output of cast-iron water pipes by a factor of 2.8, thus bringing their production up to 1.3 million tons per year. At the same time it is also necessary to solve a complex of problems related with the increase of labor productivity in pipe casting, with a decrease in the production cost of pipes, the introduction of progressive methods of casting, and an economy of metal. Of considerable importance in this complex of problems is the use of high-strength cast iron, the mechanical properties of which, being close to those of steel, will make it possible to enlarge the field of application of cast-iron pipes.

At the present time pressure pipes made of gray cast iron are mainly used for water conduits working under a pressure of 5-15 atm (gage). An insignificant portion of the pipes is used in the chemical industry in the production of soda.

The rather narrow field of application of these pipes is explained by the low reliability of the hub-and-spigot joints,which cannot withstand pressures greater than 15 atm (gage) and by the poor ductile properties of gray iron.

The production of high-strength cast-iron pipes can be accomplished by various methods. Of considerable interest is the method of pressing developed by the Ukrainian Scientific Research Institute for Pipes which makes it possible to produce pipes with small diameters (38-120 mm) and thin walls (3.5-6 mm) with a length to 7 m. The pipes are pressed from tubular blanks cast by any method. The most promising is casting the blanks by the continuous or semicontinuous method.

Casting of pipes of high-strength cast iron is now being done on centrifugal machines with water-cooled dies. The production method was developed by the Pipe Institute together with the Castings Institute of the Ukrainian

Academy of Sciences and the Makeeva Pipe Casting Plant. This is the most acceptable of the existing methods of centrifugal casting. Large mixture-preparation departments are not needed when this method is used since the weight of the sand core forming the bell is approximately 1-2% of the pipe weight. The casting process can be completely mechanized and certain operations can be automated, thus creating good sanitary and hygienic working conditions for the maintenance people and increasing the efficiency of the equipment.

According to this method, the molten cast iron is treated with metallic magnesium in an autoclave prior to pouring into the die. This assures obtaining spheroidal graphite in the structure of the pipes, thanks to which the cast iron acquires high mechanical properties.

The mechanical properties of the centrifuge-cast pipes of gray and high-strength cast iron and of the steel seamless hot-rolled pipes are shown in the table.

Mechanical Properties of Pipes

Material	Yield strength, kg/mm^2	Bending strength, kg/mm^2	Relative elongation, %	Impact strength, $kg \cdot m/cm^2$	HRB
Gray iron	18–30	28–40	0.5	0.3–0.6	187–269
High-strength cast iron	45–60	80–100	1.5–12	1.5–6.0	180–241
St. 3	40	–	22	12–15	–
St. 5	50	–	17	5–6	–

It is apparent from the table that high-strength cast iron is somewhat inferior to steel in ductility but surpasses it in the strength indexes.

The accumulated experience of producing gray-iron pipes by the semicontinuous method and also the experiments on casting pipes of high-strength cast iron by the same method permit the assertion that this method will occupy a leading position in the production of cast-iron pipes with a diameter greater than 300 mm.

The introduction of butt welding and the elimination of bells will make it possible to change over to the more progressive method of casting, i.e., the continuous method whose advantages of production can already be determined on the basis of the available experience on casting pipes by the semicontinuous method.

The production of bell-less pipes will permit a simplification of the construction of molds and elimination of both sand and metal cores.

In addition to the simplification of the design of the machine and the facility of its maintenance, the quality of the cast pipes will be appreciably improved by this process. With the semicontinuous method of casting, the main defects are located on the first meter of the pipe (from the bell end) as a consequence of which the pipes are frequently rejected. With the continuous method this shortcoming is of no great importance since the defects are formed only at the beginning of the casting process due to the great drop height of the stream of molten cast iron. Defects are not formed during a steady process when the stream has a minimum and constant drop height. The defective section can be cut off without harm, which can not be done in the case of pipes with bells. Because casting can proceed continuously for several hours, the proportion of wastes (the defective section) is very small.

The shrinkage properties of cast iron have a considerable effect on the process of continuous pipe casting. Investigations showed that the smaller the preshrinkage expansion of the cast iron and the greater its pre-pearlitic shrinkage, the more poorly the process takes place (stoppages in the production flow, difficulties in dislodging the pipes at the beginning of the process, etc.).

High-strength cast iron has a large preshrinkage expansion and small pre-pearlitic shrinkage, thanks to which the casting of such pipes is considerably facilitated.

Cutting the ends off pipes occupies a significant place in the over-all manufacturing cycle in present-day pipe-casting shops. For this purpose the shops are equipped with special pipe-cutting machines, each of which is serviced by one worker. With continuous casting the use of improved and more efficient methods of cutting the cast iron will

eliminate from the manufacturing process the cutting of uneven pipe ends. The Leningrad Institute of the All-Union Scientific Research Institute of Electric Welding Equipment is developing a method of gas-electric (plasma) cutting. With continuous casting it is possible to use this method to cut pipes of any length directly on the casting machine.

Such a clean cut is obtained with gas-electric cutting that there is no need for further cutting of the pipes on the pipe-trimmers. This has a considerable effect.

Pipes of gray iron as a rule are joined by bells cast along with the pipes. The bells are cumbersome, require a considerable expenditure of labor when assembling pipe lines, and moreover, do not make it possible to use fully the safety factor of the pipe material. If the pipe is tested at a pressure of 25-35 atm (gage), then the joint withstands not more than 15 atm (gage). Therefore one of the important problems is the development of a method for butt welding cast-iron pipes when installing pipe lines. The solution of this problem will make it possible to use pipes of high-strength cast iron with a normal wall (according to All-Union State Standard 9583-61) for high-pressure piping [up to 50 atm (gage)], which will increase their capacity without changing expenditures for construction. For ordinary pressures [5-15 atm (gage)] it becomes expedient to use thin-walled pipes with a wall 25-40% smaller than called for in the aforementioned State Standard.

The introduction of butt welding will yield a considerable saving in metal due to eliminating the cumbersome joints, which in turn leads to a simplification of both the method of producing pipes and installation of pipe lines.

If gray-iron pipes are now used mainly for water conduits, then pipes of high-strength cast iron can replace the steel pipes in oil lines, gas lines, and in enterprises of the chemical industry. An especially significant economic effect can be expected from the use of cast-iron pipes in the chemical industry because they have higher corrosion resistance in comparison with carbon steel (especially in basic media). The resistance of cast iron in basic media is five to ten times that of steel. This will make it possible in many cases to use cast iron in place of hard-to-get stainless steel. The operation of the apparatus between repairs will be increased several times when cast iron replaces carbon steel, and this will also have an economic effect and will reduce downtimes of the equipment.

Thus the use of high-strength cast iron will permit a more efficient use of pipes and will broaden their field of application.

ALL-UNION CONFERENCE OF ROLLING-MILL OPERATORS – PRODUCTION OF GRADE-STEEL ROLLED GOODS

Translated from Metallurg, No. 11,
pp. 29-31, November, 1961

The All-Union Conference of Rolling-Mill Operators, which concerned the production of grade rolled goods, was held in June of this year in the ancient Ural city of Zlatoust, the native city of Russian Damascus steel and high-grade alloy steel. Attending the conference were about 400 persons, workers of metallurgical and machinery-building plants, scientific research institute, planning organizations, State Plan workers, those of the Councils of National Economy, representatives of the editorial boards of technical journals and newspapers, of scientific and technical societies of ferrous metallurgy, and party, trade-union, and council workers.

Thirty-five reports were presented at the conference for discussion. These reports considered the main problems in the production of grade rolled goods: the design and operation of equipment, the prospects of the production and use of new steels and alloys, means to improve the quality of metal, and the mechanization and automation of industrial processes.

M. A. Pertsev, member of the State Plan, USSR, gave a report, "The Principal Trends in the Development of Rolled Stock from Grade Steels." He briefly dwelled on the main stage in the development of quality metallurgy in our country, on the enormous attention that is now being devoted to increasing the output of grade metal; he noted the chief problems that metallurgists must solve in the near future. One of these problems is the further mechaniza-

tion and automation of manufacturing processes, the struggle for an improvement in grade and commercial types of metal. The reporter devoted considerable attention to the reconstruction of rolling-mill equipment, to innovations in methods of producing grade rolled stock which must be introduced in the near future, and to specific problems the solution of which is necessary for the further development of our science and technology.

M. B. Blyakherov, engineer of the All-Union Institute for the Design and Planning of Metallurgical Plants, spoke on the contemporary state of the production of rolled stock from grade steel in the USSR and abroad and on the main trends in the planning of rolling mills. The greatest shortcoming in rolled-stock production noted by Blyakherov is the low level of mechanization of a number of sections in rolling shops, especially the sections preparing the metal for rolling and finishing the rolled product. Here manual labor predominates, and up to 50-60% of the shop workers are thus occupied. Many rolling mills do not answer modern production requirements; at a number of plants the reducing mills are not of the required power, thus necessitating the use of small ingots. Flame scarfing of metal in the production line is slowly being utilized in our plants. Heat treatment of metal, which is mainly limited to annealing, is insufficiently used. As a result of this, the required quality of the finished product is not always attained. For instance, the presently used technology and equipment for the production of cold-rolled electric steel does not ensure a sufficiently high grade of the metal. The reporter proposed to mechanize such laborious processes as cooling, dressing, and sorting of metal, to improve the quality of ingots, to introduce electric soaking pits; he recommended studying the experience of using in the rolling shops of grade-steel plants mechanized continuous units for shot-blasting semi-finished goods and installing such units at a number of plants.

Doctor of Technical Sciences M. V. Pridantsev (Central Scientific Research Institute of Ferrous Metallurgy) reported on the prospects of the production and use of new steels and alloys. The demand for steels and alloys with high characteristics of strength and with special properties is increasing in our country. To produce them it is necessary to develop new regimes of rolling and treating that are different from those presently used. Numerous new problems and unsolved questions face the rolling-mill operators in this field. Their solution will depend on the creative thoughts of the operators and on their endeavors to introduce new and advanced methods.

P. P. Menushenkov, director of the Zlatoust Metallurgical Plant, elucidated the economic problems of producing grade steels at the enterprise; he dwelled in detail on the works of the engineers and innovators that were directed toward improving the grade of metal, especially high-alloy steels. For example, the use of hot drawing of metal will permit the plant to save about 100,000 rubles per year.

There was a considerable discussion at the conference concerning the problem of specialization of plants of grade metallurgy. Comrade Slavkin (Moscow Region National Economic Council) deems it expeditious to organize the production of grade steels on the base of powerful plants together with the construction of special enterprises for the production of different steels (heat-resistant, precision, etc.). This will make it possible to increase rapidly the production capacity of grade rolled stock, to ensure production of these steels by a good mixture, to produce grade rolled stock on powerful equipment from large ingots with large reductions. A shop for precision alloys was built at the "Elektrostal'" Plant, but due to the inadequate power of the plant and a number of other reasons their production method still remains imperfect.

Comrade Skobolov (Chelyabinsk State Institute for the Design and Planning of Metallurgical Plants) fully supported the idea of specialization of plants of grade metallurgy since this will make it possible to produce rolled stock of greater diversity and in larger lots, which is what will be done by future, highly efficient mills. Comrade Kontsevaya ("Serp i Molot" Plant) also raised the question of specializing the sheet-rolling shop of the plant for the production of sheets only of stainless, heat-resistant, and high-speed steel. In this case it will be possible to realize the perfected process of producing high-speed steel developed by the plant.

Justified reproofs of certain speakers (Comrades Slavkin and Terent'ev of the "Krasnyi Oktyabr'" Plant; Zenchenko of the Novolipetsk Plant; Luzik of the Il'ich Plant, etc.) were directed toward the planning organizations (particularly the State Institute for the Design and Planning of Metallurgical Plants) whose plans for grade metallurgy frequently lag behind the contemporary level of the development of science and engineering. Unfortunately, at the conference the representatives of this State Institute did not point out in what direction will the production of rolled stock of grade steel be developed in order to satisfy the ever-growing demand.

The speakers devoted great attention to the quality of steel and cast-iron rolls. Comrades Terent'ev and Avrunin ("Dneprospetsstal'" Plant) pointed out the low quality of rolls manufactured by DZMO (Dnepropetrovsk) for structural mills and also the steel rolls manufactured by the Elektrostal' Heavy Machinery Plant and the cast-iron rolls made

by the DChVZ Plant (Dnepropetrovsk). In addition, they proposed to re-examine the All-Union State Standards and technical specifications for all types of rolls and particularly for cold-rolling rolls in order to introduce mandatory inspection of the entire section of the rolls and not just the surface, as is stipulated in the existing State Standards.

Speakers Kandaurov (Zlatoust Plant), Isupov (Serov Combine), Belyakov (Novosibirsk Plant), Zenchenko (Novolipetsk), Luzik (Il'ich Plant) and others reported on the experience of their plants concerning the reconstruction of shops and equipment, improvement of the quality of rolled stock, organization of dressing finished metal, etc.

Comrade Lyambakh (TsLa) reported on the problem of automating the control and regulating processes while rolling. Measurement of the width, length, and thickness of rolled stock is already automated at certain plants. But the demands of the workers in grade metallurgy for automatic machines are still great. The rolling mills and their auxiliary equipment are still insufficiently mechanized and automated.

The conference adopted a detailed resolution. The important problems facing the scientific research institutes and plant laboratories are the conduction of investigations and experimental works in order to improve the quality of ingots with respect to the macrostructure and surface of existing and new types of steels; the development of a theory and practice for hot-working difficult-to-form steels and alloys in order to effect a maximum change from forging to rolling; the development of conditions for forming metal on the blooming mills and structural mills in order to ensure high-grade workpieces with respect to the macrostructure; the development of high-speed regimes for the regulated cooling of rolled stock in the production line; the selection of the design and equipment of sheet mills for rolling high-alloy steels; investigation of new methods which will make it possible to reveal surface defects in the production line in place of chemical etching; the development of an efficient method for producing two-ply and three-ply steels at the existing plants and plants now being constructed.

The planning organizations together with the State Plans and Councils of National Economy must plan and introduce pits for heating grade steels with minimum scale formation and decarburization, must develop new progressive types of designs for pits with electric heating, with an upper burner for heating, as well as automated four-zone walking-beam furnaces, etc. For heat treatment of merchant metal it is necessary to design box furnaces with outside mechanization, to use extensively the roller-hearth furnaces for heat treatment of sheet steel; the designs should provide for non-oxidative heating and the use of protective atmospheres; there should be specialized, highly efficient structural and merchant mills for rolling carbon- and high-alloy steels and alloys, induction furnaces, equipment for new types of mechanical treatment—vacuum rolling, hot pressing, etc., the possibility of collecting, when hot-working, all types of alloy wastes (trimmings, abrasive dust, scale, shavings from hot and cold sawing, etc.) with sorting of the alloy wastes according to the main groups.

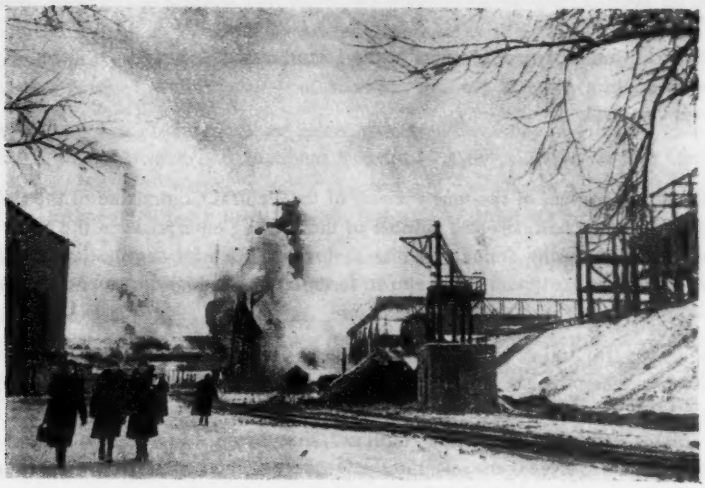
The conference deemed it necessary to construct specialized rolling shops for the output of grade and high-grade metal and also to reconstruct the present rolling mills. Along with the development of specialized shops for rolling grade and alloy metal, it is expeditious at plants for ordinary rolled products to construct specialized rolling shops for the production of grade metal, since in this case the problems of supplying a quality charge are satisfactorily solved and there is the possibility of using the present equipment; it is expeditious to accelerate the reconstruction of metallurgical plants producing grade rolled stock according to the available plans; to use more extensively progressive and economical heating devices—the electric pits, the modern three- and four-zone furnaces; the rolling equipment at the present shops must be modernized by increasing the motor power, strengthening the gear mechanisms and rolling stands, installing roller bearings, and mechanizing the feed and discharge of rolled stock; the elimination of rolling defects at the first reduction should be done as much as possible in the production line.

The conference requested the Councils of National Economy involved in the production of grade and alloy metal to deliver metal strictly conforming to the standards for highly efficient automatic production lines.

In the near future it is necessary to expand the production of merchant shapes of instrument, carbon, and high-speed steels as well as of hot-rolled and cold-rolled high-speed sheet and thin cold-rolled high-speed strip; to develop extensively the production of sections of stainless and heat- resistant steels; to increase the production of wire and strip from resistant alloys; to organize the production of cold-rolled stainless sheet 0.8-3.0 mm thick and up to 2-2.5 m wide and cold-rolled stainless sheet 0.3-0.8 mm thick and up to 1.5-2 m wide; it is necessary to continue work on expanding the production and use of chrome and chrome-manganese sheets, the substitute of chrome-nickel sheet.

It is necessary to increase the production of sized cold-drawn steel; to expand the production of cold-drawn shapes; to use extensively in the national economy low-alloy steel of high strength in places of carbon steel; to improve considerably the technology of producing electric steel.

The conference was well organized. The participants had the opportunity to become acquainted with the Zlatoust and Chelyabinsk Metallurgical Plants and also to visit the municipal Museum of Local Lore and the Il'men reserve.



Lipetsk Plant

THE GENERAL DESIGN OFFICE OF THE CHELYABINSK METALLURGICAL PLANT

P. F. Smirnov

Trade-Union Central Committee of Workers in the Metallurgical Industry
Translated from Metallurg, No. 11,
pp. 32-33, November, 1961

In response to the announcement of the June Plenum of the Central Committee of the Communist Party of the Soviet Union, the engineers and technicians at a number of the leading enterprises in the Urals resolved to help gratuitously inventors and innovators during their free time—to develop plans for automation and large-scale mechanization, modernization of obsolete equipment, and also to formulate technical documentation with respect to the plans for carrying out organizational and technological measures.

The organization of general design offices was carried out earnestly at the Chelyabinsk Metallurgical Plant at the end of 1960. The head engineer of the plant, Comrade Lubenets, issued a directive requiring that the chiefs of shops and departments, together with the trade-union shop committees, acquaint the engineers and technicians of the enterprise with the "Principle of the General Design Offices", that they aid in the organization of general design offices in all shops of the enterprise, allot them suitable space, provide the necessary inventory and materials, and also that they select qualified consultants from the shop engineers.

General design offices have already been established and are working in the sinter, coke-by-product, blast-furnace shops, in the No. 1 and No. 3 electric-steelmaking shops, the No. 1 rolling shop, the section shop, section-casting department and certain other shops of the plant. Almost everywhere the initiators were young workers, engineers, and technicians.

A general design office was organized in December, 1960 in the section shop. It consisted of 26 persons, including: senior designer Suslov; rolling-mill mechanics Il'ichev, Pyatnitsa, Orlov; fittings mechanic Kuznetsov; brigadier of mechanics of the finishing section Comrade Grishin; and certain others. These people resolved to help the enterprise, the plant innovators and inventors to introduce more quickly into production new techniques, large-scale mechanization and automation, and the most valuable suggestions from the innovators.

Simultaneously with this, the young specialists will supplement their school knowledge with practice, and will perfect their experience. The innovators, by working in the general design office, can learn to carry out more complex drawings.

The trade-union shop committees, together with the Council of the All-Union Society of Inventors, intelligently approached the selection of the staff for the general design offices. The shop workers of the planning and designing offices became part of the staff and in a number of cases headed the work of the general design office. Thus, in the No. 1 rolling shop the general design office is supervised by engineer-designer Ryabitsev, in the coke by-product shop by engineer-designer Pravdin, etc.

Active participation of the designers in the work of the general design offices makes it possible for the other members of the office to receive qualified consultations from them at all times. In addition, in the planning and estimate department of the plant, a group of consultants was organized consisting of highly qualified specialists to help members of the general design offices on all problems of developing suggestions of innovators, technological improvements, and designing. This group includes Comrade Akatov, supervisor of the blast-furnace sector; Comrade Fedorov, supervisor of the steelmaking sector; Comrade Gol'der, supervisor of the rolling-mill sector; Comrade Kopytov, supervisor of the mechanical sector, and others; Comrade Kuznetsov, deputy chief of the planning and estimate department, heads the group.

At its first meeting the members of the general design office of the No. 1 electric-steelmaking shop, which included 12 young production foremen, elected steelmaker-foreman Comrade Azikov, who is one of the most active

innovators, as director of the general design office. He worked out a schedule for the fulfillment of tasks by members of the office, and this schedule was then approved at one of the meetings of the general design office. According to this schedule, a specified theme for suggestions with an approximate period of time for fulfilling the task was allotted to each member of the office for development. Also, a member of the design office must inform the director of the office concerning the progress of fulfilling the assignment. Here, for example, are several episodes from the life of the general design office of the Chelyabinsk Plant.

Comrade Smakotin, chief of the furnace bay, suggested manufacturing special racks for storing electrodes. This suggestion was creatively worked out by Comrade Dorozhkin, member of the general design office. The chairman of the trade-union shop committee, Comrade Klyuchkin, suggested a special grinding device with two stones for dressing ingots. This suggestion was executed in the drawings of Comrade Azikov, director of the general design office.

Comrade Tyurin, brigadier of electricians, suggested changing the shape of the cam gear of the metal ejector on the coolers of the 300-2 mill. However, he could not trace out the most efficient curve for the valve lift. Engineer Il'ichev, former mechanic of this mill, helped to solve this problem. He worked on it until the drawing was completed. Comrade Il'ichev and the author spent more than a month and a half on this work.

For greater specialization of the members of the general design office, the directors of the All-Union Society of Inventors and Innovators and of the general design office of the section shop (Comrades Demenko, Zhilkin) decided to create within the general design offices four groups, three of which are allotted to the 300-2, 240, and 780 mills (one to each mill) and one to the finishing section. All innovators' suggestions and improvements pertaining to a given unit are henceforth worked out by that group of the general design office which is allotted to the unit. Senior mechanics of the mills head each group.

It was decided at the meeting of the members of the general design offices to dispense with the services of the planning and estimate department of the plant in developing and designing the suggestions of the shop innovators.

During the first quarter of 1961 the members of the design offices developed andcompleted drawings for carrying out ten large-scale innovators' suggestions. Many hours of tedious, persistent work went into developing most of these suggestions. Comrade Piskunov, worker of the Chelyabinsk Scientific Research Metals Institute, suggested manufacturing a damper out of refractory material on a water-cooled body. Comrade Pashnin, to whom this suggestion was assigned to develop, spent over three months to convert this idea into drawings.

In its practical work, the general design office of the section shop devotes considerable attention to the fastest development of those suggestions which will yield the greatest economic effect. From a preliminary estimate of the introduction of just one suggestion developed by the design office, "A Change in the Design of Packing Tables of the Cooler of the 300-Mill", will be saved 1700 kg of bronze, 195 m of high-pressure hoses, and more than 400 kg of expensive lubricants.

The members of the general design offices actively participate in the work of the entire collective of the shop on rendering aid to one of the largest State farms in the region. The members of the design offices spent much labor on developing plans for individual units and equipment being built in the department of the workshop for the repair of tractors.

Along with developing suggestions of innovators and aiding agriculture, the specialized groups of the design office have additionally pledged to solve the laborious problems of large-scale mechanization and automation of individual units of the greatest production bottlenecks.

Engineer Pyatnitsa's group of the design office is now working out a plan to mechanize lifting the arresting devices behind the shears of the 240-cold-cutting mill, and engineer Suslov's group is successfully working on the reconstruction of centerless grinders and on automation of opening and closing the gates in the finishing shop.

Eleven members of the general design office of the No. 1 shop (Comrade Ryabitsev, director) joined the ranks of the composite brigades of innovators, and together with them are developing the most important problems of modernization of machinery and equipment.

Comrade Ryabitsev, director of the general design office, together with a group of innovators, is working in the composite brigade to design a marking machine for the 350-mill. Comrade Natykin, member of the design office and assistant chief of the equipment shop, along with the composite brigade, is working on the problem of organizing, developing, and perfecting hardfacing of rolls and other rolling equipment.

The industrial activity of the workers, engineers, technicians, and office personnel has sharply increased in recent years at the Chelyabinsk Metallurgical Plant. In the first six months of the current year many more suggestions and inventions have been submitted and adopted than during all of 1959.

Of course, with an increase in the number of suggestions submitted in the shops, their delivery to the planning and estimate department of the plant for approval increased. The Komsolmol organization of the department showed valuable initiative in developing the idea of creating general design offices. The young engineers and technicians of the departments, Comrades Garelik, Davidenko, Tokarev and others, are among the group initiating the acceleration of examination and approval of suggestions submitted from the shops. During free time they and the shop workers and authors of the suggestions examined and concluded on tens of suggestions comprising about 15% of all suggestions submitted to the planning and estimate department for approval.

Much still remains to be done at the plant to improve the work of the general design office. In a number of shops these design offices do not have sufficient space, they do not all have the necessary tools and equipment, some are in great need of help from the shop trade-union organizations, especially to accelerate the introduction of those suggestions which were worked out by members of the general design office. But what has been done already fosters the further growth of creative initiative and industrial activity of the collective of the enterprise.

EN ROUTE TO INCREASING THE PRODUCTIVITY

G. I. Brodskii

Translated from Metallurg, No. 11,
pp. 33-34, November,1961

The collective of the Petrovskii Dnepropetrovsk Metallurgical Plant successfully completed the second year of the Seven-Year Plan and is not reducing its tempo in the current year.

The plan for the first months of this year has been fulfilled for the entire metallurgical cycle, and thousands of tons of metal have been produced ahead of schedule in excess of the established plan.

Year by year the plant increases the production of pig iron, steel, and rolled products. For instance, in 1960 the production of pig iron was 20% and steel 8% more than the preceding year. The qualitative indices for reducing the cost of production have been improved considerably this year. The cost of production of pig iron was reduced by 3%, steel by 2.98%. The plan for the productivity of labor was overfulfilled by 0.6%; compared to a corresponding period of last year, the productivity of labor increased by 1.7%.

The blast furnace operators have appreciably improved their work. The average utilization factor for the capacity of blast furnaces is 0.719.

During the first half of 1961, the steelmakers tapped an average of 9.14 tons of steel per 1 m^2 of hearth area, whereas the plan called for 9 tons.

What are the main factors for increasing the productivity? Let us dwell on the most important of them.

The improvement in production methods and the use of natural gas in blast-furnace production and oxygen in converter production were significant in the plant's achievement of high production indices.

The collective decided to fulfill ahead of schedule the State Plan for the third year of the Seven-Year Plan for the entire metallurgical cycle and to give to the country, in excess of the plan, 5,000 t of pig iron, 13,000 t of steel, and 14,000 t of commercial rolled products. These obligations are being considerably overfulfilled. Since the first of the year thousands of tons of pig iron, steel, and rolled products have been produced.

The successful fulfillment of the State Plan and obligations is first of all fostered by the widely developing competition for the title of Brigades, Shock-workers, and Enterprises of Communist Labor. On 1 July 1961, 620 collectives

were contending for this high title and 42 brigades had already been awarded it. They are the initiators of highly efficient labor in their shops.

The engineers of the shops and offices of the plant management are related by an intimate friendship with the life of these brigades. The problems of the best organization of labor and preparation for production, of providing conditions for achieving high working indices of the brigades, sections, and the shop as a whole are solved jointly.

As a rule, the Brigades of Communist Labor overfulfill the technical norms of production, work without rejects, do not permit downtimes of the machinery and thus ensure overfulfillment of the production assignment.

Last year the Brigade of Communist Labor of the No. 2 open-hearth furnace, where steelworker I. A. Shpak works, produced 1600 t of steel over the annual plan, and this year the brigade is working even better. Thus work all the brigades in the converter, open-hearth, and other shops.

Great attention at the plant is devoted to problems of automation and mechanization of labor processes. The realization of these measures in this area will make it possible to release many workers and thus fill out undermanned sections.

Mechanization and automation of industrial processes have already released 102 persons. The plant has already mechanized the delivery of samples in the converter shop and manipulation on the front side of the finishing stand of the 800-mill; the arresting devices of the hot-cutting saw and the transfers in the section shop, the arresting devices of the 550-mill, etc., have been automated.

At a number of shops, labor-consuming processes have been mechanized, which facilitated the labor of the workers. The delivery of pressed articles which previously was a very laborious operation is now accomplished by an electric carriage in the refractories shop. The delivery of clay in this shop is also mechanized. The rolling stock in the transportation shop has been refitted with automatic couplers, and car-dumpers were introduced.

The plant this year is taking measures to automate the blast heaters of the blast-furnace shop, the heating processes of the recuperative pits of the rail and beam shop, to automate the heating processes of the open-hearth furnaces, and to use in blast furnaces natural gas and an oxygen-enriched blast; in converters operating with an oxygen blast, blowing of the melt will be ended at a given carbon content by using an oxygen integrating instrument.

With each month mechanization and automation are introducing more widely into metallurgical production. Switching of the blast heaters from blowing to heating and vice versa has already been automated on two blast furnaces. Work is now being carried out to automate the blast heaters of another blast furnace. The circuit of this automatic device at our plant was the first to be introduced in the republic. It makes it possible to stabilize the blast temperature and to increase the efficiency of the blast heaters.

The realization of these and other measures will ensure the overfulfillment of the State Plan for production.

The propagation of the work of innovators and the leading workers plays a major role in increasing the productivity of labor.

There are numerous technical descriptions of the most efficient working methods at the plant. Schools of the most efficient working experience have already been held with respect to 39 of these technical descriptions; these are the experience of P. S. Makhota, steelworker and Hero of Socialist Labor; P. I. Egorov, blast-furnace operator and Hero of Socialist Labor; cupola-furnace operator N. G. Chernoivanenko, and many other leading production workers.

The shop foremen, engineers, and technicians actively participate in these schools.

The results of studying and propagating the experience of innovators are very indicative. For instance, the cutters of the sheet-rolling shop increased the fulfillment of the present norms from 101 to 106-108%. The press operators of the refractories shop increased their rate of work and fulfilled the norms not by 103% as previously, but by 110-112%.

An improvement in the works of the inventors and innovators at the plant has already had an effect on increasing the productivity of labor.

The society of the All-Union Society of Inventors and Innovators has considerable authority at the plant.

It suffices to note that 3039 suggestions were submitted from 1418 authors during the year. An economic saving of 1,136,000 rubles has already been obtained from the 1325 suggestions that have been introduced.

The metallurgists of the plant repeatedly occupy first place in the socialist competition among enterprises of the metallurgical industry.

In the third year of the Seven-Year plan the collective of the Petrovskii Plant is going all out for a profitable operation by the maximum use of facilities and all possible improvement of the organization of labor and production.

The metallurgists of the Petrovskii Plant are not resting on their laurels, they are busy improving production methods, mastering new complex rolled shapes, and copying the experience of the leading plants with respect to large-scale mechanization and automation.

LET US CONSTANTLY STUDY AND INTRODUCE THE POSITIVE INDUSTRIAL EXPERIENCE IN IMPROVING HYGIENE OF WORKING CONDITIONS

M. E. Zhilo

Translated from Metallurg, No. 11,
pp. 35-37, November, 1961

In 1960 the Central Committee of Workers in the Metallurgical Industry created a special brigade of engineers to study the positive industrial experience of management and trade union committees in improving working conditions at sinter plants of the Southern Mining and Concentration Combine (YuGOK) in Krivoi Rog, the Kamysh-Burun Iron-Ore Combine, and the "Zaporozhstal'" Metallurgical Plant.

Below is an article by M. E. Zhilo, supervisor of the brigade.

Sintering of iron ores in the USSR is developing unusually fast. The USSR occupies first place in the world in the production and use of sinter.

Construction of new, and reconstruction of existing sinter plants and an increase in the rate of work of the sintering machines are presently being carried out to meet the demand for sinter of the ever-expanding blast-furnace output. Along with this, work is being carried out to improve the labor conditions at sinter plants. However, the working conditions in many sectors of sinter production still do not satisfy sanitation and hygiene requirements. This is confirmed by the fact that certain groups of workers are granted additional leave due to working under harmful conditions, and special protective clothing is issued free of charge.

Work to improve the working conditions from a health point of view is being carried out at all sinter plants. Considerable successes have been achieved in this field in recent years at certain enterprises. Unfortunately, the industrial experience of individual enterprises is inadequately studied and its exchange is organized quite poorly. Many very effective measures used at some sinter plants are completely unknown at others. Little attention is devoted by planning organizations to a study of industrial experience.

The Central Committee of the Trade Union of Workers in the Metallurgical Industry has recently studied in earnest the organization of exchange of experience in improving labor conditions. An investigation of a number of enterprises of the South showed that numerous technical and organizational measures have been worked out and adopted at sinter plants to improve the conditions of labor, and many basic problems on combatting harmful conditions in sinter production have now been solved.

Especially significant achievements in improving working conditions have been accomplished at sinter plants of YuGOK, which had started operation with considerable shortcomings in the area of sanitary engineering. During the initial period of operation, the dust content of the air at a number of working sites exceeded by hundreds of times the permissible limits; on the galleries where the charge flows the visibility did not exceed 0.5 m due to fog. The air in the working areas and especially in the sintering department was severely contaminated with carbon dioxide. The heated surfaces of the firing furnaces, the walls of the vacuum chamber, the gaslines, return bunker, and incandescent charge radiated much heat.

In recent years much work has been done at the YuGOK to improve the labor conditions of the sinter workers. This work is being carried out according to the plan for organizational and technical measures which was worked out by the director of the combine and plant committee of the trade union.

Considerable success has been achieved in the struggle against one of the most harmful factors in the production of sinter—dust, containing up to 16% free silicon dioxide. The struggle against dust is being waged mainly with the wide use of water for wetting down the starting materials at all stages of crushing, grinding, measuring and when

being moved around, and for cleaning the rooms, cleaning the dust-laden air in the scrubbers, ventilating pipes, etc., and also by using large air-tight covers for all the dust-raising equipment (crushers, grinders, screens, conveyers, belts, etc.) in order to localize the dust where it occurs and devices to remove dust-laden air from under the covers; this air is cleaned prior to its release into the atmosphere. By completely covering the belts carrying sinter and by making air-tight the openings where the unloading sections of the sintering machines pass through the walls of the buildings, there was a significant reduction in the suction of extraneous air by the exhaust fan and thus the dustiness of the air in the sintering shop was lowered.

The dust-removing devices on the ventilating pipes of the rear sections of the sintering machines collect up to 100 t of dust per day. The dust which is removed as slurry is taken out to dumps. Previously it was ejected into the atmosphere, thus dirtying the area of the sintering plant.

The installation of shields on the fixed chutes which are connected with the movable ones proved its value in preventing the drift of dust and gases into the sintering department when the wind was directed toward the chutes where the sinter is discharged.

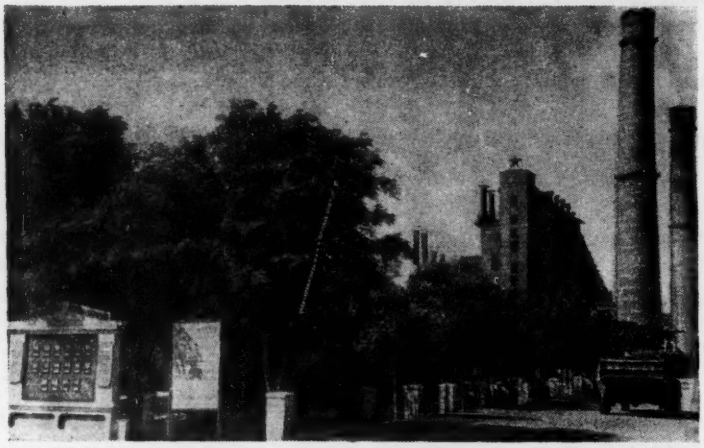


Fig. 1. Sintering Plant of the Kamysh-Burun Mining and Concentration Combine.

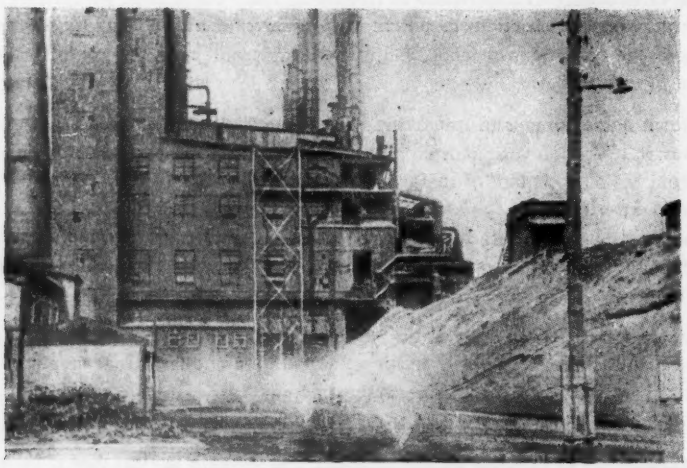


Fig. 2. Watering the yard with sprayers at the sinter plant of the "Zaporozhstal'" Plant.

The square by-pass pipes for rock waste, which had sharp angles, were replaced by oval pipes with straighter angles which made it possible to seal them and to eliminate completely periodic clogging of the pipes with material.

Covering the unloading ports of the limestone bunkers with conveyer belts provided a good seal of the bunkers and improved exhaust of the dust being formed in them.

According to the plan, unsuitable small coverings had been installed on the hot-return conveyers the material being transported was spilled, and much dust and gases were released into the air. The dust content in these sections sometimes reached 7000 mg/m^3. Previously, six men worked per shift to gather the spillage. After installing larger air-tight coverings, the air from under which is exhausted, this work is now done by only one person.

To eliminate spilling materials onto the floor from the revolving-plate feeder, sides were installed on the plates, thus making it possible to release the workers who previously hand-gathered the spillage.

The dust settling on the floor, equipment, constructions, and walls of the working areas is an additional source of air contamination. Cleaning the walls and equipment by wetting them down with water was not provided for in a single sinter plant inspected. At each sinter plant this problem is solved during operation. For this purpose the floors were reconstructed, drainage systems installed, electric wiring changed, and the walls of the rooms were protected from the destructive effect of water.

An ordinary whitewash solution with the addition of 10% water glass was used at the sintering plants of YuGOK for protecting the walls from water. This solution withstands up to 20 washings with a fire hose and, moreover, whitewashing the walls with this solution improves the illumination of the rooms.

The dust is washed off the floors each shift in the working rooms of the sinter plants of YuGOK, and from the walls and equipment twice a month. All dust removed as slurry is sent to the slurry dumps; in all up to 500 t of dust is removed per day. Previously this dust was scattered over the territory. Planting of trees and shrubs and laying of asphalt in the area of the sintering plants, its periodic watering, and a regular collection of the dust considerably decreased the dustiness of the air.

Insulation of surfaces radiating heat (the hot-return bunkers, walls of the vacuum chambers, walls and roofs of the firing furnaces, the gas collectors of the sintering machines) and shielding are used to combat the liberation of heat. The netted water-bathed shields installed on the sides of the firing furnaces almost completely check radiant heat.

Casing of the equipment and installation of exhaust hoods (over the shuttle feeder, over the hearths of the sinter conveyer belts) are used to combat the release of gases, and preheated air is delivered to combat the formation of fog.

In addition to all this, a number of very important organizational measures have been carried out at the sintering plants of the YuGOK, which have played an important role in improving the working conditions. The most important of them should be considered the organization of a dust-ventilation service at the combine. This service periodically repairs the sanitation equipment and ventilation devices and cares for them, investigates the effectiveness of the equipment, establishes optimal regimes for operating the equipment, and searches for new ways and means to improve the existing units and to introduce new, perfected means and methods for improving working conditions.

The executive directors and trade-union organizations devote considerable attention to problems of improving the working conditions at the YuGOK.

The large-scale plans for measures to be taken to improve sanitation are systematically checked by special offices organized by the trade-union plant committee. To solve certain complex problems connected with improving working conditions at the sinter plants, the management of the combine and the plant committee of the trade union repeatedly announce contests for the best suggestions. Thanks to this, problems connected with covering the vibrating screens, the head and rear sections of the sintering machines, an improvement in the design of the by-pass pipes, etc., were successfully solved.

The attention and systematic aid from the side of the community were one of the decisive factors promoting the realization of a number of large-scale measures to sanitize the working conditions at the sinter plants of the YuGOK.

As a result of the work done to create healthy conditions at the sinter plants of the YuGOK, the effect of almost all harmful factors has been significantly reduced. The dustiness of the air in many sections is now close to the

sanitary standards; for example, at the working site of the sinter workers, according to the date of the laboratory of the dust-ventilation service, a minimum dust content in the air is noted, 1.5 mg/liter, in the rooms of the return cycle and of the secondary-mixing drums the content is 2.3 mg/liter, at the working sites of the machinists of the charge feeders it is 1.3 mg/liter.

Fig. 3. Sprinklers used at the sinter plants to lower the dust content of the air.

According to the conclusions of the Krivoi Rog Institute of Labor Hygiene and Occupational Diseases, the content of carbon dioxide in the work rooms of most sinter plants is within the limits of hygienic standards. The concentration of ammonia vapors (at places where the coke is transported) and of sulfur dioxide does not exceed the norm.

At the sinter plant of the Kamysh-Burun Mining and Concentration Combine, which also went into operation with serious shortcomings in sanitary engineering, work on improving the labor conditions started only recently, after the decree of the Presidium of the Central Committee of the Trade Union dated 28 April 1959.

Thanks to carrying out a number of measures recommended by the branch conference on improving working conditions in sinter production, certain achievements have been accomplished in combating dust at the sinter plant of this enterprise.

Much attention is devoted here to mechanization of heavy work. For instance, the conversion of the firing furnaces from solid to liquid fuel released 24 workers; the introduction of washing out the multicyclone dust and housing the floors made it possible to eliminate these operations, which required heavy manual labor; automatic discharge of the dust from the dust bags of the gas collector made it possible to set up a regular schedule for discharging the dust and to eliminate the use of manual labor for this operation. The good condition and upkeep of the territory of the sinter plant attracts attention.

The sinter plant of the "Zaporozhstal'" Plant waters the yard area with sprinklers mounted in an asphalt covering and also uses a device to localize the dust forming when the sinter is discharged into the hoppers. Prior to the installation of this device the dust content of the air at unloading sites reached 200 mg/m^3. The dust-laden air is removed from under the covers and before ejecting it into the atmosphere it is cleaned of dust. This installation collects up to 15 t of dust a day.

The work carried out by the brigade permits us to make the following brief conclusions:

1) Much work is being done to sanitize the working conditions at all sinter plants inspected.

2) Unfortunately, industrial experience in this field is inadequately studied; there is no systematic information on the achievements of individual enterprises, as a result of which certain enterprises often work on the same projects that are already used successfully at other enterprises.

3) The planning institutes, by not studying the industrial experience of enterprises, permit serious shortcomings to be in the plans in the section on sanitary engineering, which must be eliminated during operation.

4) Enterprises have accumulated considerable experience in the matter of improving working conditions at sinter plants; with the proper study and generalization of this experience, valuable material can be obtained for an efficient sanitation of the working conditions at sinter plants.

M. V. LOMONOSOV AND FERROUS METALLURGY, IN COMMEMORATION OF HIS 250TH ANNIVERSARY

V. B. Yakovlev

Translated from Metallurg, No. 11,
pp. 38-39, November 1961

There is probably no field of science which is not associated with the name of the great Russian scientist M. V. Lomonosov. "By combining an unusual will power with an unabated power of understanding, Lomonosov embraced all fields of education. The thirst of knowledge was the strongest passion of his soul, which was full of passions. Historian, rhetorician, mechanic, chemist, mineralogist, artist, poet—he attempted all and understood all", wrote A. S. Pushkin about him.

Of all his numerous works, M. V. Lomonosov devoted two to metallurgy: "Fundamentals of Metallurgy or Mining" and the dissertation "On Metallic Luster." Judging by individual comments of Lomonosov, he wrote the book, "Fundamentals of Metallurgy or Mining", in 1742 immediately after completing his studies abroad. For some unknown reason this book was not published until 1763.

Prior to Lomonosov's writing of the first book on metallurgy in the Russian language, books on metallurgy were known in the world's literature: in the Italian language by V. Biringuccio (1540), in Latin by G. Agricola (1556), in English by Dudley (1665), in French by R. A. Reamur (1718 and 1722) and in Swedish by Swedenborg. Lomonosov was acquainted with these works and used them extensively in the work, "Fundamentals of Metallurgy or Mining." Considerable attention was devoted in this book to methods of extracting noble and nonferrous metals from ores. The description of a blast furnace was accompanied by a drawing taken from the work of the Swedish philosopher and student of metallurgy, Swedenborg. The construction of this furnace differed from others by wall bracing which was made in the form of a massive wooden frame. Furnaces of such design were widely used in Sweden. In Russia the blast furnaces were constructed with stone (later brick) massive frames braced with iron bands. Only in the Olentsk area did the laying of furnaces, built under the supervision of V. Gennin, have wooden bracing consisting of separate beams layed horizontally "criss-cross" and braced with iron bands.

The book describes in detail the blast furnace, the processes of charging, and tapping of pig iron, which made it very useful; M. V. Lomonosov's book could be used as a guide when constructing and operating blast furnaces.

In the first half of the 18th Century several variations of making bloomery iron were known, and M. V. Lomonosov described the simplest. The drawing of the bloomery did not contain certain details which were indicated in the text. However, even this brief account of methods for making iron and producing steel could serve as a handbook in the metallurgy of iron.

Of considerable importance for understanding the law of gas motion, even at the present time, are the conclusions cited by Lomonosov in this book in the first supplement, "On the Observed Free Motion of Air in Mines", where proof is given of the phenomenon noticed by G. Agricola, but who was unable to explain it. Lomonosov observed in the Freiberg mines how during the summer the air moved throughout the workings through the mouth of the shaft and escaped through the low-lying adit; in the winter the movement of air was in the opposite direction, thanks to which a natural ventilation of the mines was maintained. Lomonosov applied the explanation of this phenomenon to reverberatory furnaces ("self-blowers") equipped with a pipe and thus advanced the first theory of a chimney.

Much of what Lomonosov achieved in the field of theoretical chemistry bears a direct relation to metallurgy. Therefore, Lomonosov should be considered the founder of theoretical metallurgy.

At the beginning of the 1740's chemists considered water and air as elements because they knew very little about the processes of burning and oxidation (the conversion of metals to "ash") and almost nothing about the process of reduction. Scientists, by observing the conversion of metal to oxide under the effect of high temperature, developed two hypotheses in chemistry. According to each of them, fire was assumed to be a special "igneous matter" or "ther-

mogen" which, when a vessel with a metal was heated, passed through the vessel walls to the metal, uniting with it and increasing its weight; according to the second hypothesis it was assumed that "phlogiston", being contained in all combustible bodies, participates in the processes of burning and creating oxides.

The nature of this "phlogiston" or "combustible principle" remained unknown and therefore the scientists of that time built various hypotheses concerning it. Some supposed that "phlogiston" was a weightless principle yielding light and luster and assuming the form of fire in the presence of air. Others considered it as a certain specific substance having weight which is contained in all combustible substances, especially sulfur. However, to explain the increase in weight on roasting the metal, a negative weight was ascribed to the "phlogiston."

In spite of all the different opinions on the nature of "phlogiston", this theory gave a powerful impetus to chemistry. The "phlogiston theory" is contradicted by the contemporary theory of combustion which considers that, when objects are burned oxygen combines with them and decomposition of the oxides occurs on reduction. In the words of F. Engels, chemistry "was freed from alchemy by the phlogiston theory."

M. V. Lomonosov opposed the thermogen theory. In particular, in his renowned study, "Reflections on the Cause of Heat and Cold", he sharply criticized R. Boyle (the English physicist and chemist) who said that the increase in weight when metals are roasted is due to combining with the igneous matter. Lomonosov proved that a certain substance combines with metals on roasting, but in no way is it thermogen. This was especially demonstrated with clarity on roasting a metal in a closed vessel which was weighed before and after heating and no change in weight was detected, i.e., although the metal was converted to "ash" no "igneous matter" penetrated the vessel.

At the beginning of 1745, when Lomonosov was appointed a professor of the Academy of Science, i.e., an academician, it was suggested to him that he write a work on metallurgy. Mikhail Vasil'evich wrote the dissertation, "On Metallic Luster." By "luster" he meant that integral part of a metal which abandons it when roasted. Thus, "metallic luster" corresponds to "phlogiston" which is liberated, so to speak, from burning bodies. Here he expressed a number of suppositions departing from the phlogiston theory.

The works of Lomonosov were long the only metallurgical handbooks written in Russian by a Russian scientist. They were of practical value for the development of metallurgy in our country, which is indicated by the great demand for the book, "Fundamentals of Metallurgy or Mining", immediately after its publication. Later this book was repeatedly reissued. Of all the works of Lomonosov, the works on metallurgy were the least valued and sometimes even quite improperly received. For instance, in 1777 an unknown author published in the St. Petersberg Journal No. 21, a comment on Lomonosov's book, "Fundamentals of Metallurgy or Mining" that amounted to saying that the book is a translation of "Metallurgy" by H. Schluter published in 1738. This falsehood was repeated for a long time in a number of investigations, and only in 1900 did V. I. Vernadskii first compare Lomonosov's book with that of Schluter and showed that they had nothing in common. Lomonosov's works on metallurgy demand an even more attentive examination in connection with the latest achievements of modern science. This will make it possible to reveal new aspects in the creativity of Lomonosov, to make important and interesting the details that previously seemed unimportant.

ALEKSEI MIKHAILOVICH PITERSKII

Translated from Metallurg, No. 11,
p. 40, November, 1961

Aleksei Mikhailovich Piterskii, one of the oldest workers in ferrous metallurgy, member of the Communist Party since 1919, recipient of a special pension, died on 14 September 1961 at the age of 65 after a serious illness.

A. M. Piterskii began his labor career in 1913 as an office apprentice. After the Great October Socialist Revolution he actively participated for five years in the work of trade union organizations in the Urals, and then for 12 years he worked at managerial positions in the system of workers' cooperatives in Baku, Moscow, Magnitogorsk, and Sverdlovsk.

In 1933 A. M. Piterskii was appointed Deputy People's Commissar of Heavy Industry, of the Main Administration of Workers' Supplies, and then of the Main Administration of the Metalwares Industry.

From 1937 to 1942, A. M. Piterskii carried out great work in the People's Commissariat of Machinery Building and Armaments, and from 1942 was deputy minister of ferrous metallurgy for 15 years.

A. M. Piterskii gave his strength and energy to the organization of workers' supplies in heavy industry and to the development of ferrous metallurgy.

By his modesty, principles, persistence in work, and industriousness he won universal respect.

The fruitful work of A. M. Piterskii in industry was marked by high government awards—Order of Lenin, Order of the Red Banner of Labor, "Badge of Honor", and by medals.

The shining example of Aleksei Mikailovich Piterskii will long be retained in the memory of all who knew him as a comrade.

Soviet Journals Available in Cover-to-Cover Translation

ABBREVIATION	RUSSIAN TITLE		TITLE OF TRANSLATION	PUBLISHER	TRANSLATION BEGAN Vol.	Issue	Year
AÉ	Atomnaya énergiya		Soviet Journal of Atomic Energy	Consultants Bureau	1	1	1956
Akust. zh.	Akusticheskii zhurnal		Soviet Physics – Acoustics	American Institute of Physics	1	1	1955
	Antibiotiki		Antibiotics	Consultants Bureau	4	1	1959
Astr(on). zh(urn).	Astronomicheskii zhurnal		Soviet Astronomy–AJ	American Institute of Physics	34	1	1957
Avto(mat). svarka	Avtomaticheskaya svarka		Automatic Welding	British Welding Research Association (London)		1	1959
	Avtomatika i Telemekhanika		Automation and Remote Control	Instrument Society of America	27	1	1956
	Biofizika		Biophysics	National Institutes of Health*		1	1957
	Biokhimiya		Biochemistry	Consultants Bureau	21	1	1956
Byull. éksp(erim). biol. i med.	Byulleten' éksperimental'noi biologii i meditsiny		Bulletin of Experimental Biology and Medicine	Consultants Bureau	41	1	1959
DAN (SSSR) } Dokl(ady) AN SSSR }	Doklady Akademii Nauk SSSR		The translation of this journal is published in sections, as follows:				
			Doklady Biochemistry Section	American Institute of Biological Sciences	106	1	1956
		Life Sciences	Doklady Biological Sciences Sections (Includes: Anatomy, biophysics, cytology, ecology, embryology, endocrinology, evolutionary morphology, genetics, histology, hydrobiology microbiology, morphology, parasitology, physiology, zoology sections)	American Institute of Biological Sciences	112	1	1957
		Life Sciences	Doklady Botanical Sciences Sections (Includes: Botany, phytopathology, plant anatomy, plant ecology, plant embryology, plant physiology, plant morphology sections)	American Institute of Biological Sciences	112	1	1957
		Chemical Sciences	Proceedings of the Academy of Sciences of the USSR, Section: Chemical Technology	Consultants Bureau	106	1	1956
		Chemical Sciences	Proceedings of the Academy of Sciences of the USSR, Section: Chemistry	Consultants Bureau	106	1	1956
		Chemical Sciences	Proceedings of the Academy of Sciences of the USSR, Section: Physical Chemistry	Consultants Bureau	112	1	1957
		Earth Sciences	Doklady Earth Sciences Sections (Includes: Geochemistry, geology, geophysics, hydrogeology, mineralogy, paleontology, petrography, permafrost sections)	American Geological Institute	124	1	1959
		Earth Sciences	Proceedings of the Academy of Sciences of the USSR, Section: Geochemistry	Consultants Bureau	106-123	1-6	1957-1958
		Earth Sciences	Proceedings of the Academy of Sciences of the USSR, Sections: Geology	Consultants Bureau	106-123	1-6	1957-1958
		Mathematics	Doklady Soviet Mathematics	The American Mathematics Society	131	1	1961
		Physics	Soviet Physics–Doklady (Includes: Aerodynamics, astronomy, crystallography, cybernetics and control theory, electrical engineering, energetics, fluid mechanics, heat engineering, hydraulics, mathematical physics, mechanics, physics, technical physics, theory of elasticity sections)	American Institute of Physics	106	1	1956
		Physics	Proceedings of the Academy of Sciences of the USSR, Applied Physics Sections (does not include mathematical physics or physics sections)	Consultants Bureau	106-117	1	1956-1957
Derevoobrabat. prom-st'.	Derevoobrabatyvayushchaya promyshlennost'		Wood Processing Industry	Timber Development Association (London)		9	1959
	Élecktrosvyaz		Telecommunications	Massachusetts Institute of Technology*		1	1957
Éntom(ol). oboz(renie)	Éntomologicheskoe obozrenie		Entomological Review	American Institute of Biological Sciences	38	1	1959
Farmakol. (i) toksikol(ogiya)	Farmakologiya i toksikologiya		Pharmacology and Toxicology	Consultants Bureau	20	1	1957
FMM	Fizika metallov i metallovedenie		Physics of Metals and Metallography	Acta Metallurgica*	5	1	1957
Fiziol. zhurn. SSSR (im. Sechenova)	Fiziologicheskii zhurnal im. I. M. Sechenova		Sechenov Physiological Journal USSR	National Institutes of Health*		1	1957
Fiziol(ogiya) rast.	Fiziologiya rastenii		Plant Physiology	American Institute of Biological Sciences	4	1	1957
	Geokhimiya		Geochemistry	The Geochemical Society		1	1958
FTT	Fizika tverdogo tela		Soviet Physics–Solid State	American Institute of Physics	1	1	1959
Izmerit. tekh(nika)	Izmeritel'naya tekhnika		Measurement Techniques	Instrument Society of America		1	1959
Izv. AN SSSR, O(td). Kh(im). N(auk)	Izvestiya Akademii Nauk SSSR: Otdelenie khimicheskikh nauk		Bulletin of the Academy of Sciences of the USSR: Division of Chemical Sciences	Consultants Bureau		1	1952

continued

Izv. AN SSSR, O(td). T(ekhn). N(auk): Met(all). i top.	(see Met. i top.)				
Izv. AN SSSR Ser. fiz(ich).	Izvestiya Akademii Nauk SSSR: Seriya fizicheskaya	Bulletin of the Academy of Sciences of the USSR: Physical Series	Columbia Technical Translations	1	1954
Izv. AN SSSR Ser. geofiz.	Izvestiya Akademii Nauk SSSR: Seriya geofizicheskaya	Bulletin (Izvestiya) of the Academy of Sciences USSR: Geophysics Series	American Geophysical Union	1	1954
Izv. AN SSSR Ser. geol.	Izvestiya Akademii Nauk SSSR: Seriya geologicheskaya	Izvestiya of the Academy of Sciences of the USSR: Geologic Series	American Geological Institute	1	1958
Kauch. i rez.	Kauchuk i rezina	Soviet Rubber Technology	Research Association of British Rubber Manufacturers	18 1	1959
	Kinetika i kataliz	Kinetics and Catalysis	Consultants Bureau	1 3	1960
	Koks i khimiya	Coke and Chemistry USSR	Coal Tar Research Association (Leeds, England)	1	1958
Kolloidn. zh(urn).	Kolloidnyi zhurnal	Colloid Journal	Consultants Bureau	14 1	1952
	Kristallografiya	Soviet Physics – Crystallography	American Institute of Physics	2 1	1957
Metalov. i term. obrabot. metal.	Metallovedenie i termicheskaya obrabotka metallov	Metal Science and Heat Treatment of Metals	Acta Metallurgica	6 1	1958
	Metallurg	Metallurgist	Acta Metallurgica	1	1957
Met. i top.	Metallurgiya i topliva	Russian Metallurgy and Fuels	Eagle Technical Publications	1	1960
Mikrobiol.	Mikrobiologiya	Microbiology	American Institute of Biological Sciences	26 1	1957
OS	Optika i spektroskopiya	Optics and Spectroscopy	American Institute of Physics	6	1959
	Pochvovedenie	Soviet Soil Science	American Institute of Biological Sciences	1	1958
	Priborostroenie	Instrument Construction	British Scientific Instrument Research Association	1	1959
Pribory i tekhn. éks(perimenta)	Pribory i tekhnika éksperimenta	Instruments and Experimental Techniques	Instrument Society of America	1	1957
Prikl. matem. i mekh.	Prikladnaya matematika i mekhanika	Applied Mathematics and Mechanics	American Society of Mechanical Engineers	1	1958
PTÉ	(see Pribory i tekhn. éks.)				
	Problemy Severa	Problems of the North	National Research Council of Canada		
Radiotekh.	Radiotekhnika	Radio Engineering	Massachusetts Institute of Technology*	12 1	1957
Radiotekh. i élektronika	Radiotekhnika i élektronika	Radio Engineering and Electronics	Massachusetts Institute of Technology*	2 1	1957
	Stanki i instrument	Machines and Tooling	Production Engineering Research Assoc.	1	1959
	Stal'	Stal (In English)	Iron and Steel Institute	1	1959
Stek. i keram.	Steklo i keramika	Glass and Ceramics	Consultants Bureau	13 1	1956
Svaroch. proiz-vo	Svarochnoe proizvodstvo	Welding Production	British Welding Research Association	4	1959
Teor. veroyat. i prim.	Teoriya veroyatnostei i ee primenenie	Theory of Probability and Its Applications	Society for Industrial and Applied Mathematics	1	1956
Tsvet. Metally	Tsvetnye metally	Nonferrous Metals	Primary Sources	1	1960
UFN	Uspekhi fizicheskikh Nauk	Soviet Physics – Uspekhi (partial translation)	American Institute of Physics	66 1	1958
UKh	Uspekhi khimii	Russian Chemical Reviews	The Chemical Society (London)	1	1960
UMN	Uspekhi matematicheskikh nauk	Russian Mathematical Surveys	London Mathematical Society	15 1	1960
Usp. fiz. nauk	(see UFN)				
Usp. khim(ii)	(see UKh)				
Usp. matem. nauk	(see UMN)				
Usp. sovr. biol.	Uspekhi sovremennoi biologii	Russian Review of Biology	Oliver and Boyd	48	1959
Vest. mashinostroeniya	Vestnik mashinostroeniya	Russian Engineering Journal	Production Engineering Research Assoc.	4	1959
Vop. gem. i per. krovi	Voprosy gematologii i perelivaniya krovi	Problems of Hematology and Blood Transfusion	National Institutes of Health*	1	1957
Vop. onk.	Voprosy onkologii	Problems of Oncology	National Institutes of Health*	1	1957
Vop. virusol.	Voprosy virusologii	Problems of Virology	National Institutes of Health*	1	1957
Zav(odsk). lab(oratoriya)	Zavodskaya laboratoriya	Industrial Laboratory	Instrument Society of America	25 1	1959
ZhAKh Zh. anal(it). khimii	Zhurnal analiticheskoi khimii	Journal of Analytical Chemistry USSR	Consultants Bureau	7 1	1952
ZhETF Zh. éksperim. i teor. fiz.	Zhurnal éksperimental'noi i thecreticheskoi fiziki	Soviet Physics–JETP	American Institute of Physics	28 1	1955
ZhFKh Zh. fiz. khimii	Zhurnal fizicheskoi khimii	Russian Journal of Physical Chemistry	The Chemical Society (London)	7	1959
ZhMÉI Zh(urn). mikrobiol. épidemiol. i immunobiol.	Zhurnal mikrobiologii, épidemiologii i immunobiologii	Journal of Microbiology, Epidemiology and Immunobiology	National Institutes of Health*	1	1957
ZhNKh Zh(urn). neorgan(ich). khim(ii)	Zhurnal neorganicheskoi khimii	The Russian Journal of Inorganic Chemistry	The Chemical Society (London)	1	1959
ZhOKh Zh(urn). obshch(ei) khimii	Zhurnal obshchei khimii	Journal of General Chemistry USSR	Consultants Bureau	19 1	1949
ZhPKh Zh(urn). prikl. khimii	Zhurnal prikladnoi khimii	Journal of Applied Chemistry USSR	Consultants Bureau	23 1	1950
ZhSKh Zh(urn). strukt. khimii	Zhurnal strukturnoi khimii	Journal of Structural Chemistry	Consultants Bureau	1 1	1960
ZhTF Zh(urn). tekhn. fiz.	Zhurnal teknicheskoi fiziki	Soviet Physics–Technical Physics	American Institute of Physics	26 1	1956
Zh(urn). vyssh. nervn. deyat. (im. Pavlova)	Zhurnal vysshei nervnoi deyatel'nosti (im. I. P. Pavlova)	Pavlov Journal of Higher Nervous Activity	National Institutes of Health*	1	1958

*Sponsoring organization. Translation through 1960 issues is a publication of Pergamon Press.

SIGNIFICANCE OF ABBREVIATIONS MOST FREQUENTLY ENCOUNTERED IN SOVIET PERIODICALS

FIAN	Phys. Inst. Acad. Sci. USSR.
GDI	Water Power Inst.
GITI	State Sci.-Tech. Press
GITTL	State Tech. and Theor. Lit. Press
GONTI	State United Sci.-Tech. Press
Gosénergoizdat	State Power Engr. Press
Goskhimizdat	State Chem. Press
GOST	All-Union State Standard
GTTI	State Tech. and Theor. Lit. Press
IL	Foreign Lit. Press
ISN (Izd. Sov. Nauk)	Soviet Science Press
Izd. AN SSSR	Acad. Sci. USSR Press
Izd. MGU	Moscow State Univ. Press
LÉIIZhT	Leningrad Power Inst. of Railroad Engineering
LÉT	Leningrad Elec. Engr. School
LÉTI	Leningrad Electrotechnical Inst.
LÉTIIZhT	Leningrad Electrical Engineering Research Inst. of Railroad Engr.
Mashgiz	State Sci.-Tech. Press for Machine Construction Lit.
MÉP	Ministry of Electrotechnical Industry
MÉS	Ministry of Electrical Power Plants
MÉSÉP	Ministry of Electrical Power Plants and the Electrical Industry
MGU	Moscow State Univ.
MKhTi	Moscow Inst. Chem. Tech.
MOPI	Moscow Regional Pedagogical Inst.
MSP	Ministry of Industrial Construction
NIIZVUKSZAPIOI	Scientific Research Inst. of Sound Recording
NIKFI	Sci. Inst. of Modern Motion Picture Photography
ONTI	United Sci.-Tech. Press
OTI	Division of Technical Information
OTN	Div. Tech. Sci.
Stroiizdat	Construction Press
TOÉ	Association of Power Engineers
TsKTI	Central Research Inst. for Boilers and Turbines
TsNIÉL	Central Scientific Research Elec. Engr. Lab.
TsNIÉL-MÉS	Central Scientific Research Elec. Engr. Lab.-Ministry of Electric Power Plants
TsVTI	Central Office of Economic Information
UF	Ural Branch
VIÉSKh	All-Union Inst. of Rural Elec. Power Stations
VNIIM	All-Union Scientific Research Inst. of Meteorology
VNIIZhDT	All-Union Scientific Research Inst. of Railroad Engineering
VTI	All-Union Thermotech. Inst.
VZÉI	All-Union Power Correspondence Inst.

Note: Abbreviations not on this list and not explained in the translation have been transliterated, no further information about their significance being available to us - Publisher.